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Fengshui principles applied to farm planning design in the Canterbury region New Zealand

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A Dissertation

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by

Jiayuan Li

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Abstract of a Dissertation submitted in partial fulfilment of the requirements for the Degree of Master of Landscape Architecture.

Fengshui principles applied to farm planning design in the Canterbury region New Zealand

by

Jiayuan Li

This study investigates the potential of using Fengshui principles in conjunction with landscape ecology principles as a lens to view farm design in order to improve the environmental conditions of farms in the Canterbury regions. This was an inductive qualitative research that involved collecting non-numerical data to understand the landscape characteristics, environmental conditions, and farm environment layouts. Three farms in the Canterbury region were selected for the case study. The research firstly analysed the layout design of each farm by using Fengshui principles. Then, it compared the redesign of each farm based on landscape ecology and Fengshui principles. The research finally discussed the possibility of applying a Chinese design approach to reduce the environmental impacts on the New Zealand landscape. The results showed that Fengshui could identify the existing environmental issues based on the concept of "Qi". These issues could also be mitigated followed the Fengshui principles. Other than this, Fengshui design considered the living quality of humans and, followed landscape ecology principles focusing on the living habitat of livestocks. After analysis and comparison, these two concepts could be combined, through compromise, hence catering for the needs of environmental conservation, as well as livestock and human livestyles. This study suggested that Fengshui principles could be applied as a guide in site inventory, analysis, and landscape planning in New Zealand, and cater for farmers' wellbeing and living environment.

Keywords: Fengshui, landscape ecology, landscape design, agriculture, farm planning, farm layout design.

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Chapter 1. Introduction

1.1 Background

Globally agriculture is on the brink of transformation (Pearson, 2020) and agricultural management needs to respond with action to address such current global environmental issues as climate change and agricultural land degradation. In the meantime, with the growth of the world's population, agriculture needs to have the capability to feed it by improving farm production. These challenges and pressures lead to an awareness of an agriculture revolution in practices that people have never experienced before.

In recent years, extraordinary changes have occurred in the relationship between agriculture and landscape architecture (Grose, 2017). Agriculture on rural farms has moved from the overriding premise of food production to biodiversity protection. Farmers are looking for a long-term design to pass on their farmland to future generations because they have started to manage their land and realized that connecting to the wider ecological world with multiple voices will maximize farms' flexibility and resilience. Landscape architects are becoming more involved in regenerative agriculture fields, which means a form of restoration ecology and conservation in an agricultural setting. Nelson Byrd Woltz, a landscape architect, has already carried out a pilot project on a sheep farm in New Zealand and his project aims to cooperate with experts from different fields to achieve ecological conservation, cultural protection, and natural element configuration. "Landscape architects are trained to deal with multiple voices", as mentioned by Grose (2017). Working with landscape architects will make a difference to agriculture because this kind of cooperation overturns piecemeal thinking, which is a one-sided logic that will mislead us into a short-term solution. The intersection of landscape design and agriculture enables landscape architects to contribute innovative rural design to shape the rural environment with some farming and environmental strategies to increase production and manage the agricultural environment.

New Zealand uses landscape ecology principles and legislation to regulate farming activity. As the most significant human influence on land in New Zealand, farming has become a core aspect of the national identity of New Zealand. The influence of agricultural activity on the environment is significant. In 2004, a report published by the Parliamentary Commissioner for the Environment mentioned that intensive agriculture could cause many environmental problems, including soil problems, water problems, biodiversity loss, and greenhouse gas emissions. Canterbury region is located in New Zealand's South Island with an approximately 20% agricultural landscape. This region has all the environmental problems caused by farming as mentioned before. The Canterbury Regional Council issued the Farm Environment Plans (FEP) (Environment Canterbury, 2020) to guide farming activities to reduce those problems and help to protect the natural environment. In recent years, the FEP has been used to regulate the agricultural activities on farms and indeed,

environmental issues have been identified, but they still exist. Farmers complain that they are charged rates on land to address the flooding and erosion issues. These issues are still have not been solved while farmers are still being charged (Houlahan, 2020). As the existing legislation has limitations in regulating farming activity to address environmental issues, there is the possibility of using Fengshui principles as an new approach for landscape architects to read the existing farm design and inspire landscape architects in designing the rural agricultural landscape.

On the other side of the world, China is a farming country with over 4000 years of history. The Fengshui concept has played a significant role in regulating human activities to cooperate with the natural environment as a critical method to configure the natural environment over history. People have used Fengshui principles to design villages and Western ecologists have proved this ancient traditional Eastern strategy is not metaphysics. Moreover, it is compatible with landscape ecological perspectives. Landscape ecology emphasizes the combination of change and adaptability between natural and human systems (Tuan, 1974), while Fengshui has major guidance on landscape planning and management in Asia (Hong, 2001). In other words, this is a landscape management system from an Eastern cultural background with unique characteristics. As Grose (2017) said, “Landscape architects in western countries are trained to design the landscape based on ecological theory; meanwhile, absorbing and dealing with multiple voices is a basic skill.” Based on the collected literature, even though Western study has affirmed the position of Fengshui principles in landscape design, there is a gap in applying the Fengshui principles in Western agricultural landscape design (Eitel, 1987; Mak, 1998). As the existing agricultural landscape in New Zealand has environmental challenges and pressures that landscape ecology cannot fully solve, it is a chance for landscape architects to seek and discover new ways to address them.

This research uses the Chinese Fengshui principles as an innovative approach to provide an alternative reading of the existing rural farm design in the Canterbury region in New Zealand, investigating the possibility of applying Fengshui principles as a method in landscape design for landscape architects in New Zealand to address selected environmental challenges. This 1-year research focuses on the three case study farms’ layout design and their existing environmental challenges in the Canterbury region.

1.2 Aim

This project aims to use Fengshui principles in conjunction with landscape ecology principles as a lens on farm design to make a contribution to improve the environmental footprint of three farms in the Canterbury region.

1.3 Objectives

The objectives to achieve in the project are to:

- Critically analyse the design of each farm layout based on Fengshui principles;
- Compare the design of each farm using landscape ecology concepts and Fengshui principles in the Canterbury region;
- Discuss the possibility of applying a Chinese design approach to help improve the agricultural environment of the New Zealand landscape.

1.4 Overview of the structure

The layout of this research is as follows.

The literature review will be divided into three parts - Fengshui theory and its application in China; landscape ecology and New Zealand legislation; and Fengshui and landscape ecology.

The methods chapter will outline the methods of this research. It will explain the approaches selected for this study, the study area selection criteria and location, and the data collection and analysis steps.

The results chapter will include the analysis of the existing farm conditions based on Fengshui principles, the farm redesign based on Fengshui and landscape ecology principles, and the final design decision to compare these two theories' strategies. For each part in the result chapter, three selected farms will be analysed separately.

The discussion chapter will show how the results support or contradict other scholarly work and thinking towards the application of Fengshui principles in the New Zealand rural farm landscape. Moreover, it will provide a viewpoint about the position of Eastern culture in a Western country.

The conclusion chapter will point to the reconciling of this work with existing knowledge, hence pointing out the limitations of this study. Future recommendations will be mentioned to discuss the future of applying Fengshui into a Western country's landscape design.

Chapter 2. Literature Review

2.1 Fengshui Principles and their Application in Asia and Western Countries

Fengshui is a practical Chinese art which intertwined with people's life and influences the aspect of shaping village landscape and city. The concept of Fengshui has been widely practiced in Asian countries rural landscape planning (Chen & Nakama, 2004). With the awareness of environmental and environmental crisis after 1960s, scholars from the Western countries started to analysis the practice of Fengshui in urban planning theoretically (Mak, 1998).

2.1.1 What is Fengshui?

Fengshui is an art of site selection in China which appeared in the Western Chou Dynasty (1100-771 B.C.) and still remains popular in Chinese societies. The first use of the word "Fengshui" was in the Qin Dynasty (221-206 BC.) by Yu Lizi (樗里子). He considered Fengshui as *"Cang Feng De Shui"* or "calming the wind and obtaining water," which was a simple description of Fengshui. Fengshui emphasizes the harmonious and balanced relationship between the human and the surrounding natural environments. In Chinese, the word "Fengshui" is divided into two parts- "Feng" means "wind," and "Shui" means "water." The Book of Burial, written by Guo Pu in the Jin Dynasty, is esteemed as the veritable 'classic' of Fengshui, and Guo Pu was also the first person to define the term "Fengshui." The Book of Burial is based on the burial of one's ancestors in an auspicious site according to the flow of "Qi" through analysing its surrounding landform.

The word "Qi" is a unique Chinese concept that can be explained as an energy that cannot be touched, seen, smelled, or tasted. It is something that is blown away by wind and accumulated by water. In New Zealand, Māori use the word "Mauri" to describe "Qi," which represents the energy that binds all things in the physical world (Royal, 2007). According to Guo (1875), "the wind will disperse the Qi, and the water will contain it… Fengshui aims to keep the Qi flowing but contained." As a compound word, "Fengshui" refers to a practice system that accumulates vital energy called "Qi," which supports all life. In other words, the concept of Qi is the fundamental premise of the Fengshui principles, which is an invisible and traditional form of energy. The application of Fengshui in landscape design can create a serene place where the Qi will flow freely (Chen et al., 2018; Han, 2001; Hong, Song, &Wu, 2007). Its goal is to achieve balance in five elements with the overall landscape design.

Fengshui study has different "schools" or methods. Some methods are easy to use, while others are more advanced and require intricate technical knowledge. In the Tang Dynasty, Fengshui was divided into two schools, the Form School and the Compass School. Over the years, the proponents of these

two schools seem to have been in conflict and competition. The Form School theories are based on actual observation of the land with explicit classification and description of the natural landscape. The Compass School is more associated with astrological considerations. The variation between these two schools is often ignored in many Western studies, especially when discussing the science of Fengshui (Hwangbo, 1999). This research will use the Form School Fengshui theory as a core concept to read and analyse the agricultural landscape. Based on the Form School concept, the study will analysis the flow of "Qi" on the site to read the layout design of the agricultural landscape.

According to Han (2001), Fengshui has endured as an art of site selection and remains popular in East Asia and even in Western countries in recent years due to the Chinese diaspora and the effort of Chinese Fengshui masters. The spread of Fengshui shows its value and effect on the modern world. As an ancient concept that has been passed down and transformed for a thousand years, "Fengshui" attracts many scholars to develop its mechanism, spiritual symbolism, and scientific value.

The study of Fengshui and its relationship with science is highly controversial among scholars worldwide. Michael Paton, an honorary associate of the School of Economics at the University of Sydney, who has a particular interest in the history and philosophy of science in China. Paton (2013) translated many Fengshui texts into English, including the Archetypal Burial Classic of Qing Wu – Burial Classic (青乌先生葬经), the Inner Chapter of the Book of Burial Rooted in Antiquity – Book of Burial (古本葬经内篇), the Yellow Emperor's Classic of House Siting – Classic of Siting (黄帝宅经), the Secretly Passed down Water Dragon Classic (秘传水龙经), and Twenty Four Difficult Problems (难解二十四篇). He mentioned that the original text was based on observing the flow of wind and water in terms of topographical form, aesthetics, and configurational force; there were few astrological considerations. According to the collected literature, these discussions affirmed that this is a theory focusing on the relationship between humans and the surrounding environment. Fengshui, as defined by Chatley (1917), is the art of adapting the resilience of living to cooperate with the natural law. This concept is admired by modern environmentalists and landscape architects like McHarg. In his book, McHarg (1969) states that it is necessary to adapt to natural laws to enhance human's life by promoting the harmony between nature and humans. There are also many voices arguing that Fengshui is pseudoscience. This is because Fengshui is considered superstitious when used as a way of determining or influencing one's prospects. Diamond (2018) mentioned that the core concept of Fengshui was monotonous because the circumstances in which people evaluate and interpret cannot be ensured to be repeated all the time. On the other hand, many European commentators read Fengshui as a scientific endeavour. Ernst Johann Eitel, a German Lutheran missionary who lived in Hong Kong for many years, sees Fengshui as Chinese natural science, but he stated that this was a science that did not mature (Matthews, 2019). As mentioned by Eitel (1987), Fengshui practice is "merely dressed-up common sense that the Chinese have made into a black art and conveyed to Western people by using a complicated compass." The argument from Eitel is

associated with metaphysics and cosmology. His statement on Fengshui only focuses on the Compass School, while the concept and theory of the Form School are entirely ignored.

2.1.2 The Application of Fengshui Principles

Fengshui has been widely applied in the East Asia landscape, especially on rural village design and urban planning. The following case studies show the application of Fengshui principles in East Asia countries and Western countries.

2.1.2.1 East Asian Country Case Study

China is a country with over 4,000 years of traditional agricultural practice. As the second-largest food production region in China, Hunan province provides 14% of the national food production and this has kept increasing year by year. In recent years, Hunan's regional agricultural policy focuses on "the three rights" policy, which refers to "collective ownership rights, household contract rights, and operational rights." The policy supports the development of local agriculture and the investment of harvesting technology to preserve the local culture and increase household production efficiency (Wang, 2020). To address the policy, several villages were selected as a pilot project. The project aimed to address the policy on an eco-agricultural model which controls soil pollution and enhances rural sanitary conditions. One of the Dong villages, located in Jingzhou Hunan, was included in the project. To follow the policy, the Dong village created an eco-friendly village and a natural farm project. Unlike other tested villages in Hunan, the Dong village design retained the Fengshui layout, which leads to an understanding of human activity with land, mountain, and water in natural landscapes. The village was designed with a watercourse mouth open space, 'wind and rain' bridge, drum tower, and staggered arrangement village (X. Li, W. Li, K. Smith & A. Smith, 2019). The village was built with a unique orientation. According to Figure 1, both Shangzhai Village and Xiazhai Village are located on the opposite bank of the river, and they occupy the favourable basin region near the bend of the river to view the water flowing inward. To avoid seeing the Shangzhai Village, Xiazhai Village faced to the southwest and Fengshui trees were planted to protect the “Sha Qi” which flowed from Shangzhai Village. Settled on the well-oriented site and surrounded by mountains and rivers, protected by the “wind and rain” bridge, both of these two villages believed they had secured a desirable arrangement (X. Li, W. Li, K. Smith & A. Smith, 2019). By following the regional policy and maintaining the Fengshui principles, the Dong village in Jingzhou achieved a low environmental impact with an over ¥800,000 annual income (Chen & Zou, 2019). The application of Fengshui in Dong village shows that Fengshui principles make a real contribution to the agricultural landscape design and creates environmental and economic benefits for farmers.

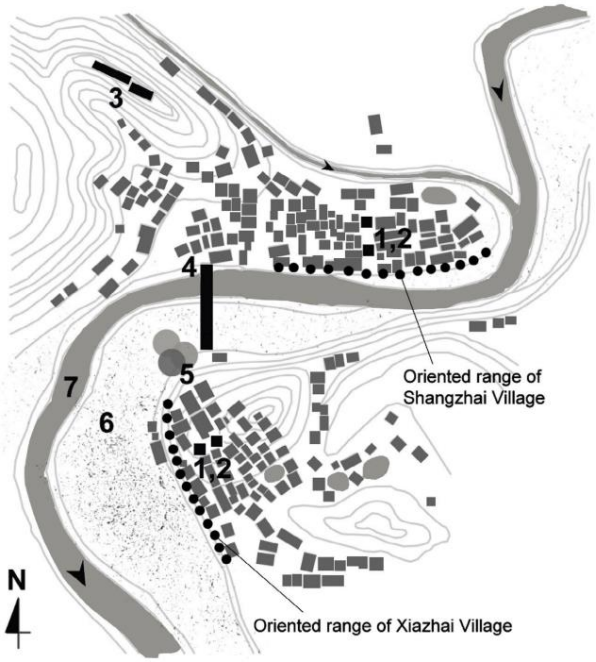


Figure 1. The layout of Dong Village: 1&2. The drum tower and performance stage; 3. Shangzhai Village School; 4. Wind and Rain Bridge; 5. Fengshui Trees; 6. Cultivation field; 7. River (X. Li, W. Li, K. Smith & A. Smith, 2019)

As well as China, Japan has also applied Fengshui principles in rural village design. Chen and Nakama (2010) explored the features of the village landscape structure in Okinawa and selected a village in Ryukyu Islands as a case study. The concept of Fengshui was firstly introduced in Ryukyu by Chinese immigrants in the 14th century and applied to guide the landscape design by Sai On in the 1730s. The Fengshui design of Ryukyu followed the Form School concepts, which focus on the physical form of the site and its surrounding environment. The Ryukyu Fengshui village features the application of tree planting to accumulate "Qi." Based on the photo (Figure 2) Chen and Nakama (2010) collected, the forest belt (called Ho:go in Japan) is planted in a curved shape in front of the village and extends west and east as a low hill, called "Zhu Que", in the Fengshui landscape. The concept of Ho:go is created by Japanese Fengshui masters based on local characteristics. Differently from the ideal Fengshui village model, which is an "armchair" shaped enclosed landscape to contain the wind and accumulate the water, the house in Ryukyu village is encircled by a multi-layered forest belt of house-embracing trees. This unique layout was designed to protect the village from typhoons. Moreover, it shows the environmental variation between mainland and island landforms. This research indicates that the application and design of the Fengshui forest in Ryukyu Island have been localized to adapt to the landform and cultural background of Japan which is different from the original Fengshui model. Moreover, it shows that the concept of Fengshui is not static. Based on the location, time, cultural background, and function, the Fengshui concept is flexible to fit with the local condition while maintaining its baseline which is to keep "Qi" flowing and contained on-site, and keep the harmonious and balanced relationship between the human and surrounding natural environments.

Figure 2. Village Ho:go Aerial Photo: (1). Bummja; (2). The back hill covered with thick forest; (3). Jaejama to:midai; (4). Tukapana; (5). Village Ho:go curving in the front; (6). J. Shiokawa Utaki; (7). Sjuga:ga; (8) Pïtumataugam (Chen & Nakama, 2010)

2.1.2.2 Western Case Study

According to Han (2001), the practice of Fengshui is complex and is generally applied by Fengshui masters rather than non-specialists, it is not common sense dressed up as something else. Limited by its unique knowledge and cultural background, it is hard to find any literature showing the real application of Fengshui principles in a Western country. Based on the information collected so far, all the studies relative to Fengshui in the Western country are based on theoretical analyse and hypotheses.

Mak (1998) explores the Form School's Fengshui design theory and principles and examines how the 20 most densely populated cities in the world conform to Fengshui principles. His research compares 20 selected cities with five geographical factors of the Form School Fengshui theory (Dragon, sand, water, cave, and direction). Among the 20 cities globally, 14 cities (70%) have the ideal composition of the five geographical factors of the Fengshui model, and 10 of these 14 cities are in Western countries (see Table 1). This result provides evidence that theoretically, the Fengshui model is applicable to other cities in the world. This research shows the people from Western countries have started to think about applying the Fengshui model outside Asia.

Table 1. Results of major cities which conform to the five geographical factors of Form School Fengshui Principles (Mak, 1998)

City	Dragon	Sand		Water	Cave	Direction
	Dragon Vein/ Tortoise Hill	Dragon & Tiger Hills	Table Hill & Facing Mt	River, Lake or Sea	Bright Court	Orientation
Tokyo	Yes	Yes	Yes	Yes	Yes	S
Mexico City	Yes	Yes	Yes	Yes	Yes	NE
New York	Yes	Yes	Yes	Yes	Yes	SW
Sao Paulo	Yes	Yes	Yes	Yes	Yes	SE
Shanghai	No	No	Yes	Yes	Yes	NE
Beijing	Yes	Yes	Yes	Yes	Yes	SE
Rio de Janeiro	Yes	Yes	Yes	Yes	Yes	E
Los Angeles	Yes	Yes	Yes	Yes	Yes	S
Bombay	No	No	Yes	Yes	Yes	E
Calcutta	No	No	No	Yes	Yes	NW
Seoul	Yes	Yes	Yes	Yes	Yes	S
Buenos Aires	Yes	Yes	Yes	Yes	Yes	NE
Jakarta	Yes	Yes	No	Yes	Yes	N
Paris	Yes	Yes	Yes	Yes	Yes	S
Osaka	Yes	Yes	Yes	Yes	Yes	SW
Cairo	Yes	Yes	Yes	Yes	Yes	W
London	Yes	Yes	Yes	Yes	Yes	E
Bogota	Yes	Yes	Yes	Yes	Yes	NE
Chicago	Yes	Yes	No	Yes	Yes	NE
Madras	No	No	No	Yes	Yes	E

Charlotte Thompson, a Bachelor's student from Lincoln University in New Zealand, used a Fengshui-inspired analysis to formulate a redevelopment plan for Christchurch city's Eastern Red Zone area (Figure 3). Thompson (2015) firstly assessed and analysed the existing environmental approaches of the Red Zone redevelopment project, then provided an hypothesis of using Fengshui as a non-Western planning theory on the Christchurch eastern residential red zone redevelopment design. In Charlotte's research, she uses the Compass School Fengshui theory to relocate the configuration and location of different features in the red zone area such as village market, school, church, community garden, main residential settlement, etc. The result of this research shows that Fengshui has the potential to change the dominant planning practices while keeping the character of the local community with unique cultural and spiritual values in New Zealand. It used the concept of the Form School and the Compass School Fengshui to provide a balanced space for residential settlement, biodiversity protection, soil remediation, and recreation.

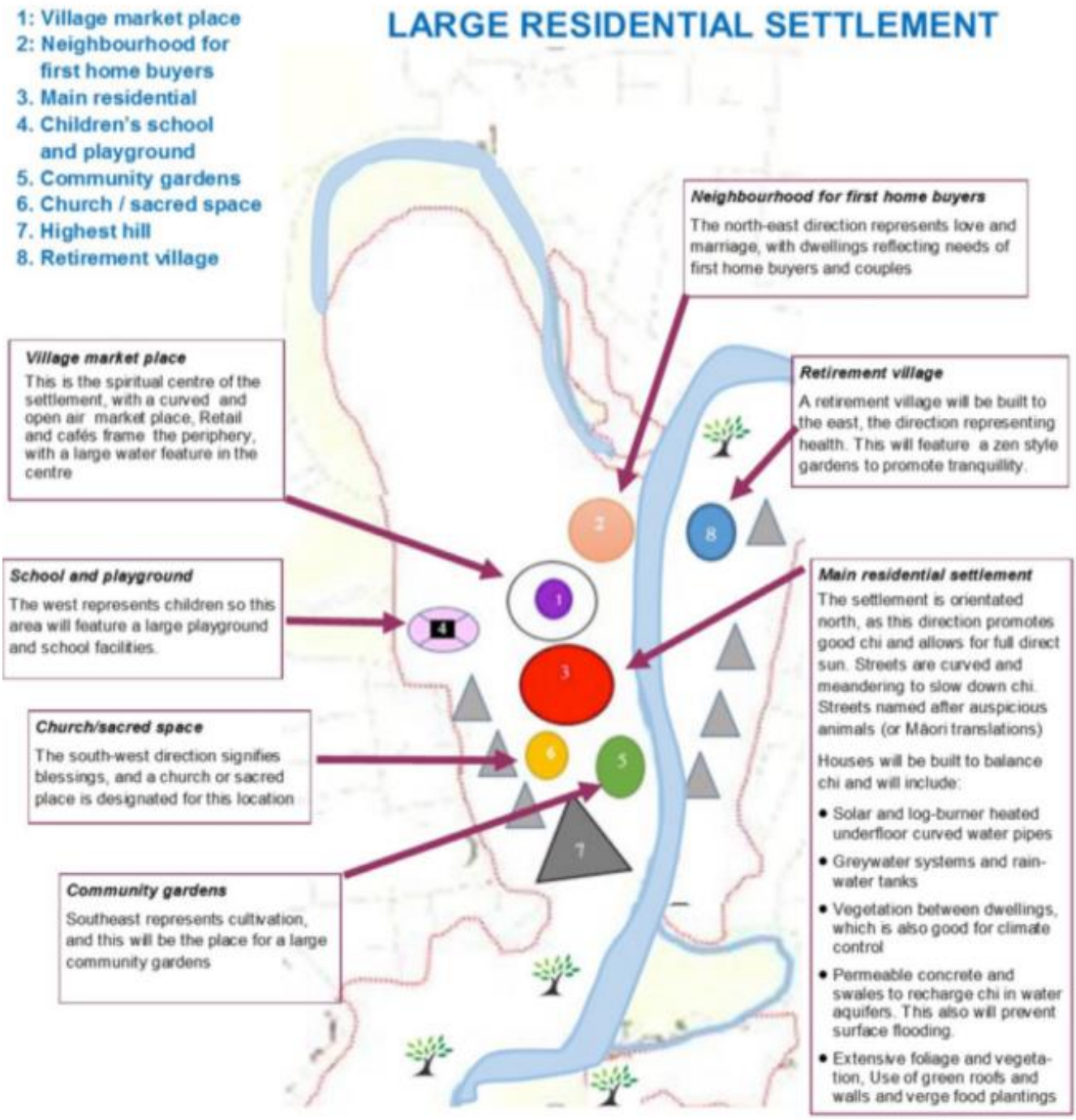


Figure 3. Detailed plan of the proposed Residential Settlement in Christchurch Red Zone (Charlotte, 2015)

2.2 Landcape Ecology and its Application in Agricultural Landscape

Landscape ecology is closely related to agriculture and farming systems through its focus on habitat fragmentation, biodiversity protection, natural restoration, and landscape pattern management (Pearson, 2020). It not only addresses the environmental challenges on landscape, but also contribute to provide advice on how to design, develop, modify, and protect landscape under human modification.

2.2.1 What is Landscape Ecology?

Langer (1970) defines landscape ecology as “a discipline that deals with spatial organization, internal functions, and mutual relations of landscape-relevant systems”. The applied field of landscape ecology in the structure of landscape includes analysis of spatial metrics and assessing hydrological, ecological, and other impacts (Lovell & Johnston, 2009). Landscape ecology is a useful method for landscape design and land-use planning which provides guidance on the spatial distribution of natural elements, including water, plants, animals, materials, etc. As mentioned by Forman and Godron (1986), landscape ecology principles have been widely used in any land type including suburban, agricultural, desert, and forest. There are three major elements guiding the general principles – patches, corridors, and matrix. Landscape architects use these elements to design spatial patterns, manage environment conservation, and to formulate land policies (Forman, 1995). The patch-corridor-matrix components determine the function and change of the landscape to address the issues and achieve sustainable development of the natural environment.

2.2.2 Landscape Ecology and the Agricultural System

In recent years, landscape ecology theory has been intensely focused on socio-economic elements of the landscape. More recently, there is a greater understanding of human-nature relationships and recognition of how to quantify landscape service provision from an environmental perspective (Brink et al., 2016). The early role of landscape ecology focused on restoration, conservation, and improving the biodiversity of the landscape (Ministry for the Environment, 1997). Landscape ecology can now be seen as playing a role in recognizing and supporting the regulation of landscape services like pollination and soil fertility that have an impact on the biophysical capacity of the agricultural system. Landscape ecology informs the restoration and preservation of biodiversity, as well as ecological integrity in the farm setting (Fahrig, 1997).

The focus of landscape ecology on the agricultural system has moved from improving management strategies to facilitating landscape pattern preservation (Moore et al., 2018). This result has led to increasing the incorporation of landscape ecology with agricultural planning and design. Nowadays, even though landscape ecology has a high potential of being applied into agricultural planning, it has not had much opportunity to become involved in creating future farm landscape design (Tran, 2020). However, there is the potential of taking the landscape ecology approach to the analysis of landscape function, hence helping to provide farmers with essential knowledge that guide management strategies and assists in making land-use decisions (Pearson, 2019).

2.2.3 Application of Landscape Ecology in the Agricultural Landscapes

Theoretically, many studies have focused on guiding the design of agricultural landscapes to enhance the biodiversity services based on landscape ecology theories. Landis (2017) lists the ecology

concepts that contribute to the agricultural landscape design (see Table 2). The calls for managing agricultural landscapes and addressing environmental issues with landscape ecology theories are not new (Landis, 2016). In 2003, the recognition of severe water quality and quantity problems prompted an ecologist from Australia to consider the redesign of the annual cropping system (Lefory, 2001). In Europe, the recognition of biodiversity loss has led to agri-environmental programs to enhance farmland biodiversity. The level of success is depended on how the biodiversity gains are valued (Kleign et al., 2006).

Land is a platform with a variety of landscape features, and landscape ecology can be seen as a tool which uses these features to influence the overall environmental system of the landscape (Table 3.). Landscape ecology can be applied on detailed landscape features hence affecting the environmental condition. Lovell and Johnston (2009) stated that agricultural development leads to habitat loss, threatens biodiversity and cause local species extinction. Studies have shown that plant biodiversity can be increased in the agricultural landscape by the conservation of the riparian habitat (Boutin et al., 2002), live fences (León & Harvey, 2006), and woodlots (Freemark et al., 2002).

Table 2. Concepts guiding the agricultural landscape design to enhance biodiversity (Landis, 2016)

Concepts	Selected references
Consider landscape impacts on biodiversity	Tscharntke et al. (2012c)
Maintain landscape heterogeneity	(Benton et al., 2003; Chaplin-Kramer et al., 2011; Woltz et al., 2012; Fischer et al., 2013; Fischer et al., 2006; Rusch et al., 2016)
Consider compositional and configurational landscape heterogeneity	(Fahrig et al., 2011; Perović et al., 2015)
Consider landscape connectivity	(Benton et al., 2003; Fischer et al., 2006)
Manage local habitats to enhance natural enemies and pest suppression	(Landis et al., 2000; Chaplin-Kramer et al., 2011; Jonsson et al., 2015)
Manage local habitats to enhance pollinators and pollination services	(Kennedy et al., 2013; Nicholls & Altieri 2013; Blaauw & Isaacs 2014; Balfour et al., 2015; Garibaldi et al., 2015; Scheper et al., 2015)
Provide early-season resources for natural enemies	(Woltz & Landis, 2013; Raymond et al., 2015)
Maintain resource continuity	Schellhorn et al. (2015)
Importance of native vegetation for biodiversity conservation	(Isaacs et al., 2009; Fischer et al., 2013; Parry et al., 2015)
Reduce field sizes	Fahrig et al. (2015)
Modify chemical use	(Gibbs et al., 2009; Fischer et al., 2013; Egan et al., 2014)
Manage timing of disturbance events	Fischer et al. (2013)
Increase perenniality	(Landis et al., 2000; Isaacs et al., 2009)
Plan for landscape multifunctionality	(Jordan & Warner 2010; Steingrover et al., 2010; Dosskey et al., 2012; Tscharntke et al., 2012c; Shackelford et al., 2013; Westphal et al., 2015)

Table 3. Farm environmental problems and related landscape features (Panday & Nkongolo, 2015; Borrelli et al., 2020; Song & Chen, 2002; Harper, 2002; Perrings et al., 1997).

	Greenhouse Gases	Soil Erosion	Water Quality	Eutrophication	Biodiversity
Pasture	√	√			√
Land use	√	√	√	√	√
Livestock	√	√	√	√	√
Soil Type	√	√	√		√
Topography	√	√	√	√	√
Climate	√	√		√	√
Plants	√	√	√	√	√
Animal	√	√	√	√	√
Catchment Hydrology	√	√	√	√	√
Land Cover	√	√	√	√	√
Wind	√	√			√

The study on applying a landscape ecological framework to better integrate nature with the New Zealand agricultural landscape has been discussed and practiced by many scholars. Meurk and Swaffield (2000) explored a vision for "a New Zealand landscape that integrates converging themes in contemporary landscape ecology and landscape architecture". The landscape elements such as roadsides, shelterbelts, hedgerows, woodlots, gardens, and riparian margins have potential to integrate and create a new landscape. They used Hawkes Bay's transitional landscape as an example to explore the potential for development in a traditional landscape, and describe a possible way to combine the elements into a regenerative agricultural landscape structure (Figure 4). Tran et al. (2020) suggest using the geodesign methods and landscape ecology theories to achieve a balance between cultural, ecological, and production functions of the agricultural landscape. These two researches show that landscape architecture can connect landscape ecology with other techniques to service the farm landscape and moreover, connect ecology with the elements in the agricultural landscape to regenerate the ecosystem and production of the land.

Figure 4. Contemporary "dysfunctional" agricultural landscape (left), and proposed integrated landscape (right) (Meurk & Swaffield, 2000).

The role of landscape ecology in sustainable agriculture is not only limited to landscape design. Pearson (2020) pointed out three key potential roles of landscape ecology by using the New Zealand agricultural landscape as a case study. The three key roles are:

(1) An informed and decision-making science of landscape evaluation,

(2) Tools and techniques for farmers on quantifying and monitoring landscape,

(3) The integration of natural values and cultural perspectives into landscape management.

Landscape ecology in the agricultural landscape is a theory that guides stakeholders, landscape architects, and farmers to make decisions on the agricultural landscape. With the assistance of the ecological approach, both the natural habitat, cultural protection, and agricultural production can maintain balance. The landscape ecology theory is essential in agricultural landscape management in New Zealand.

2.3 Fengshui and Landscape Ecology

As mentioned by Mills(1999), in the postmodern era, discourse on Fengshui reflects western values and perceptions. Fengshui has a potential role in the West to evaluate the great variety of urban and rural landscapes. Moreover, it can help people see fresh perspectives on themselves in the broader ecological communities.

The relationship between Fengshui and ecology has been documented by many scholars over the years. Ke-Tsung Han, the professor of the National Chin-Yi University of Technology, compared Fengshui with the contemporary ecological theory of human habitat selection. His results showed that these two theories have many similarities. To identify a preferrable environment for humans to live in, ecological theory identifies certain landscape features like semi-enclosed spatial configuration, depth cues, even ground textures, etc (Appendix 1). These features can be easily found in the Fengshui principles. Anderson (1996) linked the Fengshui principle with ecology. He argued that Fengshui allowed the Chinese to maintain a homeostatic relationship with the natural environment. Its concept, Yin-Yang, as Han (2001) mentioned, is a kind of energy that is the essence of all-natural environments which circulate through wind, cloud, rain, vital energy, and back to wind. Chinese people use Fengshui principles to choose the best location for their settlements and farmland which is based on the layout of the surrounding environment and called siting direction (坐向论). Hong, Song, &Wu (2007) discuss how Fengshui theory can be integrated into modern landscape ecological principles in Seoul as an example to research. In this research, they analysis the essential elements of Fengshui theory and its relationship to the modern landscape ecology principles (Table 4). In their study, they conclude that some elements of the Fengshui theory can correspond to those in landscape ecology theory and need to be further tested and refined through further studies. On the other hand, the variation in Fengshui and landscape ecology is shown in the interpretation of landscape elements including water, soil, plants, and human settlement. Table 5. lists how the scholars from different academic backgrounds define each landscape element. So far, there is no research comparing Fengshui and landscape ecology principles in a farm region.

Table 4. Comparison between Fengshui principles and landscape ecology (Hong, Song, & Wu, 2007)

Fengshui		Landscape Ecology	
Element	**Theory**	**Element**	**Theory**
Mountain	Assess the connectivity, shape, and arrangement of mountains on a regional scale (看龙法).	**Landscape Patch**	Evaluating the size, number, configuration, area-species, etc.
Water	Assess the connectivity, shape, networking with mountain to village for watershed (得水法).	**Landscape Corridor**	Corridor: Width, horizontal structure, circuitry, connectivity of corridor.
Direction' Man	Pattern, aspect and appearance of total landscape (形局论).	**Mosaics**	Patch-corridor-matrix shape/habitat arrangement/population dynamics.

Table 5. Definition of landscape elements by Fengshui principles and landscape ecology (Wu, 2000; Amr et al., 2016; Tang, Cao, & Wu, 2020)

	Fengshui	Landscape Ecology
Element	**Definition**	**Definition**
Water	Visualized form of flow of "Qi"	The media of ecological flows in landscape mosaics
Soil	The collection of "Qi" on the ground	The base of the ecosystem, supports the vegetation that depends on the air and water
Vegetation	The symbol of life, it can be used to regulate "Qi"	Single spot in the landscape, clusters of vegetation can create various landscape patterns to support the ecosystem
Road	Road is another form of water. A inappropriate design of road can bring "Sha Qi" to the site	Linear or banded landscape elements that make the spatial pattern of ecosystem holistic and internal

Generally, the difference between Fengshui and ecological perspectives is that Fengshui includes the concept of "Qi," but ecology does not. This abstract concept is difficult to substantiate using scientific methods. It encompasses holistic human interactions with their surrounding environments. From the ecological point of view, Qi regulates the microclimate of the site. Fengshui can be seen as the ecological theories using wind, water, natural habitat, and sunlight to support the microclimate to achieve sustainable development.

Fengshui principles have influenced East Asia for centuries. It is meaningful to integrate Fengshui's concepts with landscape ecology theory to create a transdisciplinary approach that applies to the Western world.

2.4 New Zealand Agricultural Management

Farming dominates 45.3% (12.1 million ha) of the total area of land use in New Zealand (Ministry for the Environment, 2019). According to the data collected by the Ministry for the Environment (2019), livestock farming, and dairy farming were the major land use types in New Zealand from 2002 to 2016 (see Figure 5).

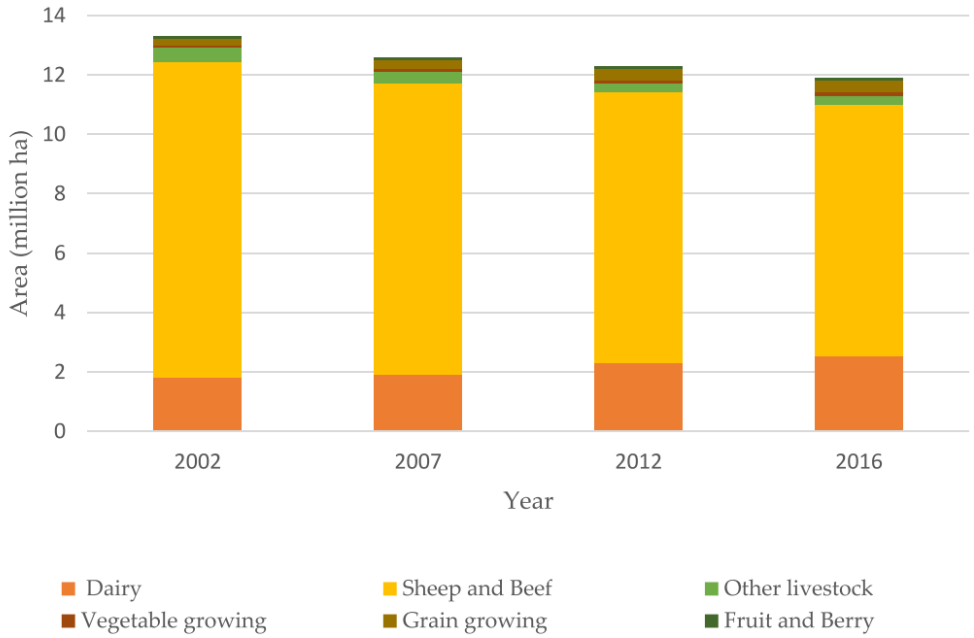


Figure 5. 2002-2016 main agricultural land use types in New Zealand (Ministry for the Environment, 2019).

The history of New Zealand land cover change can be traced back to 750 years ago when Maori first settled. About 550 years later, in the 1800s, with the expanded population of European settlers, significant impacts on land cover and land use change started as they cleared the landscape for intensive agricultural production. Since then, rural landscapes in New Zealand have been primarily dominated by family farms (Pearson, 2020).

2.4.1 New Zealand Agricultural Environmental Challenges

Under current economic globalization trends, New Zealand has used the brand of “100% Pure New Zealand” and “Pure Nature” to increase the market. The brand forces the country to face many environmental challenges associated with water quality, erosion, greenhouse gas emission, and ecosystem degradation (Ministry for the Environment, 2018). The following studies show the environmental conditions of the agricultural landscape from New Zealand to the Canterbury region.

- Water Quality

  According to the Department of Conservation (2011), water quality in New Zealand had an overall decline between 1989and 2007. Based on the analysis, pastoral farming has affected this issue directly. Between 1999 and 2010, the national dairy cattle herd increased from 3.4 million

to 5.9 million, and the use of nitrogen fertilizers also increased by over 800%. As sheep and cattle prefer to be farmed on flat country and close to water sources, the increasing pollution from intensive farmland has directly affected rivers' habitat values. To improve water quality, the government launched many policies from national to regional. In September 2020, the national policy statement for freshwater management designed to improve freshwater quality by controlling farm practices came into force. According to Kirk et al. (2020), the implementation of the policy has several barriers. Firstly, it is difficult for the freshwater management align with National Policy Statement for Freshwater Management and other national priorities and standards. Secondly, from the interview, many staff from the local government reflected that the huge barrier for the policy is money as it is over the ability to pay to achieve the policy requirement. Thirdly, lack of expertise to help answer technical questions in the remote parts of the country make it difficult to implement the policy.

As well as the water pollution problem, flooding is the most common natural hazard in the Canterbury region. Environment Canterbury (n.d.) mentioned that vast areas of the region are vulnerable to flood risk, especially in the floodplain. There are three types of flooding that affect the low-lying region: river flooding, local runoff flooding, and coastal overtopping. For the agricultural area, the costs of flooding could run into several million dollars per farm (Monhanlall, 2019). For the farm with livestock, flooding can cause tremendous ripple effects like water pollution, dairy cow milk supply, and animal feeding problems.

According to the definition of water from the Fengshui point of view, the New Zealand farms have an issue with "Qi" flow. The farm on the flat country is "extreme yang" in Fengshui, "Qi" would flow in a slow speed and it is hard for "Sha Qi" to flow out of the farm. Hence, "Sha Qi" will gather the negative energy on the farm hence affecting the natural habitat along the water channel. The farm on the floodplain has flooding potential in the rainy season, which flushes "Sheng Qi" out of the farm with water.

- Soil Erosion

As an ongoing problem in New Zealand, soil erosion has caused 200-300 million tonnes of soil to be carried out to sea and rivers every year which is far above the global average. Hill country erosion is estimated to cost between $100 million and $150 million annually (Basher, 2013). The soil erosion problem is not only because of New Zealand's active geology and hilly topography, but also due to continuous farming and grazing. According to Manaaki Whenua (2018), intensive agricultural activities weaken the soil's resilience to weathering processes through intensive grazing. Nearly 44% of the annual soil loss comes from exotic pastures. This data shows that the agricultural techniques should be revisited, especially for long-term soil system health (Petherick, 2020).

In the Canterbury region, erosion in mountain areas is accelerated by wetting and strong winds. The loss of soil in the highly eroded hilly areas has resulted in a reduction of plant cover in the pastoral farming areas (McSaveney & Whitehouse, 1989).

In Fengshui, using the plant to consolidate soil structure is the priority of erosion control. It is opposite to McSavenery and Whitehouse's point of view. Soil erosion happens due to the site's lack of vegetation to stabilize "Qi" on the ground. When strong wind or high-speed water flows through the site, without the mitigation of vegetation, the balance of the energy will be broken and hence, accelerate the erosion of soil and cause biodiversity loss in mountain area.

- Greenhouse Gas Emission

In 2004, nearly 90% of methane emissions and 95% of nitrous oxide were contributed by livestock. The contribution of agriculture to greenhouse gas emissions is far above the global average (Haggerty & Campbell, 2008) and comprises half of New Zealand's total greenhouse emission. With the continuous growth of dairy farms, it will be more difficult to reduce agricultural greenhouse gas emissions than before. The carbon dioxide emission of a single dairy cow is over 3 tonnes every year (Hutching, 2018). The government has considered levy on gas emission from farmers, but this idea was rejected because there was too much opposition (Haggerty & Campbell, 2008). On the other hand, there are thousands of hectares of pine trees planted on productive farmland to offset the dairy emissions. Planting pine trees is an effective solution for now to reduce greenhouse gas, but it is not a long-term or sustainable option for solving the greenhouse gas emission problem, moreover, it will affect the conservation of primary forest (Han & Zhu, 2020).

Recently, New Zealand passed the climate change legislation to "reduce all GHGs(except methane) to net zero by 2050". This legislation is a big challenge for each farmer as they need to calculate the current emission rate and come up with a specific plan to reduce emissions via a change in practice (Pearson, 2020). In 2018, Canterbury was recorded as the highest methane and nitrous oxide emission region in New Zealand, and the main reason is the expansion of dairy cattle numbers (Star News, 2020).

Scientists are still seeking ways to reduce the amount of GHG emission chemically, ecologically, and physically but landscape ecology can not precisely target to this environmental challenge. On the other hand, the GHG emission appeared after the mature of Fengshui principles and non of the principle has mentioned about this field, it will not be discussed in this research.

- Ecosystem Degradation

The large-scale land clearance for agriculture is another key environmental challenge in New Zealand. Most research in recent years shows that most losses of biodiversity are caused by

agriculture. The highly-modified landscape threatens the habitat and ecosystem of native species. Now, only 26% of the native forest remains in New Zealand, and most of it is in a hilly or mountainous landscape (Pearson, 2020). With the degradation of the native habitat, nearly 80% of the land vertebrates are classified at high risk of extinction (StateNZ, 2019).

Canterbury Plains are the most highly modified natural landscape in New Zealand. When the biodiversity is lost from agricultural areas, it is not merely a loss of species in a conservation aspect. The more severe sequence is that the sustainable ecosystem will be destroyed, which influences the productivity of farmland (New Zealand Ministry for the Environment et al., 2004).

The agricultural activity threatens the living habitat of Canterbury mudfish. Canterbury mudfish is included in 22 native threatened fish species and is at risk of becoming the second native fish to become extinct in New Zealand (Mitchell, 2018). As mentioned by the Department of Conservation (2018), mudfish have always been found in a land based aquatic environment such as meandering, slow flowing streams with deep pools, and stock-water races. The Canterbury mudfish's habitat is on private land which is impacted by agriculture severely, moreover, there is little protection under district and regional plan. In Fengshui, the environment such as the mudfish's habitat is an excellent place to gather "Sheng Qi" on the farm as a place full of thriving energy. The slow flowing streams of the mudfish habitat can gather "Sheng Qi" on the site, hence creating a comfortable microclimate in the farm.

In summary, there are multiple challenges that New Zealand farming systems need to face. Government legislation has already been introduced to regulate agricultural activities. For farmers, implications associated with these challenges are the need to make farm management decisions based on the condition of each farm. To address the challenges and improve the agricultural environment while ensuring a stable income, both government and farmers need assistance from scientists or professional designers to help them in making decisions. Fengshui can read these environmental challenges from the Eastern viewpoint or basically from the flow of "Qi" point of view.

2.4.2 New Zealand National Environmental Legislation

The landscape ecological approaches have been applied in the environmental ethic in New Zealand to preserve the natural environment, which is beneficial to present and future generations (Caldwell, 1988). About the New Zealand environmental policy, environmental ethics is a prerequisite for legislation that runs through the history of the environmental management process in New Zealand, from New Zealand agricultural reform to the Resource Management Act.

- New Zealand Agricultural Reform

  New Zealand is a country that depends highly on its natural resources which contributes to its export economy. These natural resources must be well managed to achieve sustainable

development, which is beneficial to future generations. To protect natural resource and to achieve a "green and clean" country image, the government creates and amends over 100 Acts and 400 regulations each year while over 750 primary Acts and 3,000 statutory regulations have been introduced since the 1860s (Valentine, 2015).

In 1980, the Organisation for Economic Co-operation and Development (OECD) highlighted that New Zealand needs to manage its local environment and especially needs to take measures to curb pollution and protect national parks and forests (OECD, n.d.). By the late 1980s, the governments decided that there was an opportunity to introduce an environmental reform regime over New Zealand, which opened a new page to create and effectively treat the farming environment. After the reform, New Zealand agriculture has become a market-oriented and highly-productive sector.

- Resource Management Act 1991

  After the environmental reform, there were more than 50 laws related to the protection of the environment. The Resource Management Act 1991 (RMA 1991) was the first statutory planning which brought those laws together and aimed to achieve a coordinated and integrated way to manage the environment under the principle of sustainability. RMA 1991 is used to promote the sustainable management of natural and physical resources (Resource Management Act 1991, s 5).

  The RMA 1991 gives everyone the responsibility and right to manage and protect the environment. By using the delegation of authority to the regional and local councils, the Act can minimize the effect of human activity on the environment according to the local conditions. The administration system provides guidance on how to manage our environment on significant issues and allows communities to make decisions targeting local environmental problems. This is an opportunity for landscape architects to apply Fengshui in analysing the environmental challenges and provide suggestions in agricultural landscape plan and design.

2.4.3 Canterbury Region Environmental Legislation

Farm planning is a useful tool for most of the regional councils to manage their agricultural activity, and which is recognized as an effective way to achieve good environmental outcomes with different forms. The Farm Environment Plans (FEP) is an environmental risk-management tool for farms and is compulsory in the Canterbury region to manage water quality (Eppel, 2015). The farm planning work in recent years has aimed at addressing sustainability by combining sustainable land management with strategies of maximizing agricultural production.

Canterbury, as the greatest region of agricultural production in New Zealand, has approximately 20% of its area in farmland. There are five regions in Canterbury: North, Central, Mid and South

Canterbury, and Banks Peninsula. The Canterbury region has nearly 3 million ha of exotic forestry and agricultural land of which one-third of the farmland is covered by tussock and grassland. The Canterbury farmland consists of a diverse mix of intensive cropping, dairy, and sheep and beef on the plains as well as on high country farms. Moreover, half of New Zealand's fodder cropland and grain seed land is in Canterbury. The integration of those farming features creates the system of Canterbury's agriculture. The integrated farm systems in Canterbury can balance the feed production and maximize the productivity both within the farm and between each farmland.

Since most of the New Zealand's agricultural production is exported, it is sensitive to the demand of overseas consumers. The economic value of the land for farming is over ecological value. To support the way they live, landowners replace native forests with exotic forests. Once planted, the sequence of the biodiversity and landscape is irreversible. Awareness of the natural conservation of the areas outside the protected area is growing recently and the key to achieving the goal is to find a new approach that can achieve natural conservation (Norton & Miller, 2000). With the growing requirement of "green" and "safe" food, farming practice has been forced to change. The farmers in the Canterbury region are forced to change their farming system and borrow the resources from future generations. As mentioned in 2.2.4.1, the change has caused several environmental problems that appear to be unsustainable in some regions.

To address those environmental problems, the central government set the Environment Canterbury as a regional council to manage the natural environment. The Farm Environment Plans and Good Management Practice are used to regulate farming activities on farmland.

- The Environment Canterbury (ECan)

  The ECan is a regional council aiming to manage the air, water, and land of the Canterbury region and is committed to the sustainable management of the natural environment while supporting the promotion of the region's social, economic, and cultural conservation (Environment Canterbury, 2020). The council has environmental plans and riparian plans to support on-farm planning for all types of rural properties. The regional council provides organization materials or contractors to support farmers. On the other hand, the government provides funding to identify and solve biodiversity issues.

- Good Management Practices (GMPs)

  Good Management Practices can be used on farms to improve the water quality, especially on phosphorus, nitrogen, sediment, and fecal contaminants. It can help farmers understand the environmental risk, assess the farm, provide management guidance, and record progress. The GMPs was developed from the Canterbury Matrix of Good Management (MPM), which was set up to develop industry-agreed good management practice. The joint initiative group includes ECan, Crown Research Institutes, primary organizations, and regional councils. With good

practice examples, farmers would be able to compare their current practice with these while assessing their opportunities and performance (DairyNZ, 2016). The GMPs are divided into several farm management areas: whole farm, plants, animals, and land. The requirements of each management area are only related to the water quality of the farm.

GMPs is a guideline that helps farmers to regulate their agricultural activity. It can provide assistance to guide farmers on how to identify the practices of the farm, hence providing useful information to help identify the environmental condition of the farm. Moreover, as a professional guideline, GMPs is under council rules and requirements and the cross-sector governance group is able to provide professional help to farmers. Its limitation is that the GMPs only focus on enhancing the water quality of the farm. Even though this is addressed in one of the four environmental challenges in the Canterbury region, it cannot be used to manage the whole farm agricultural activity to address water pollution, flooding, soil erosion, biodiversity loss, and greenhouse gas emission problems together.

- Farm Environment Plans (FEP)

FEP (Environment Canterbury, 2020) are a tool for Canterbury region farmers to help recognize the environmental risks on-farm and a programme to manage it. This plan now is only applied in the Canterbury region to minimize the existing or potential environmental risks (Figure 6). Each zone has specific rules and information. The FEP in each property is unique based on the local climate, farming operation types, farming goals, and soil conditions under Resource Manage Act 1991. The FEP guides the activity which is relevant to the farm activities and effects on water quality and land use, several rules are defined to manage the agricultural activities. In Canterbury region, an FEP is required as a condition of farmers' resource consent.

The Farm Environment Plans (FEP) is a tool used to help farmers recognize the environmental risks and provide a systematic programme to manage those on-farm risks. This is an effective and integrated method to document existing environmental issues and provide management approaches.

Farmers use the FEP as a template to guide the farmland design. For example, to manage the animal and vegetative waste and minimize the pollution on the natural environment, the plan limits the location of the waste, which is applicable to farmers (Table 6).

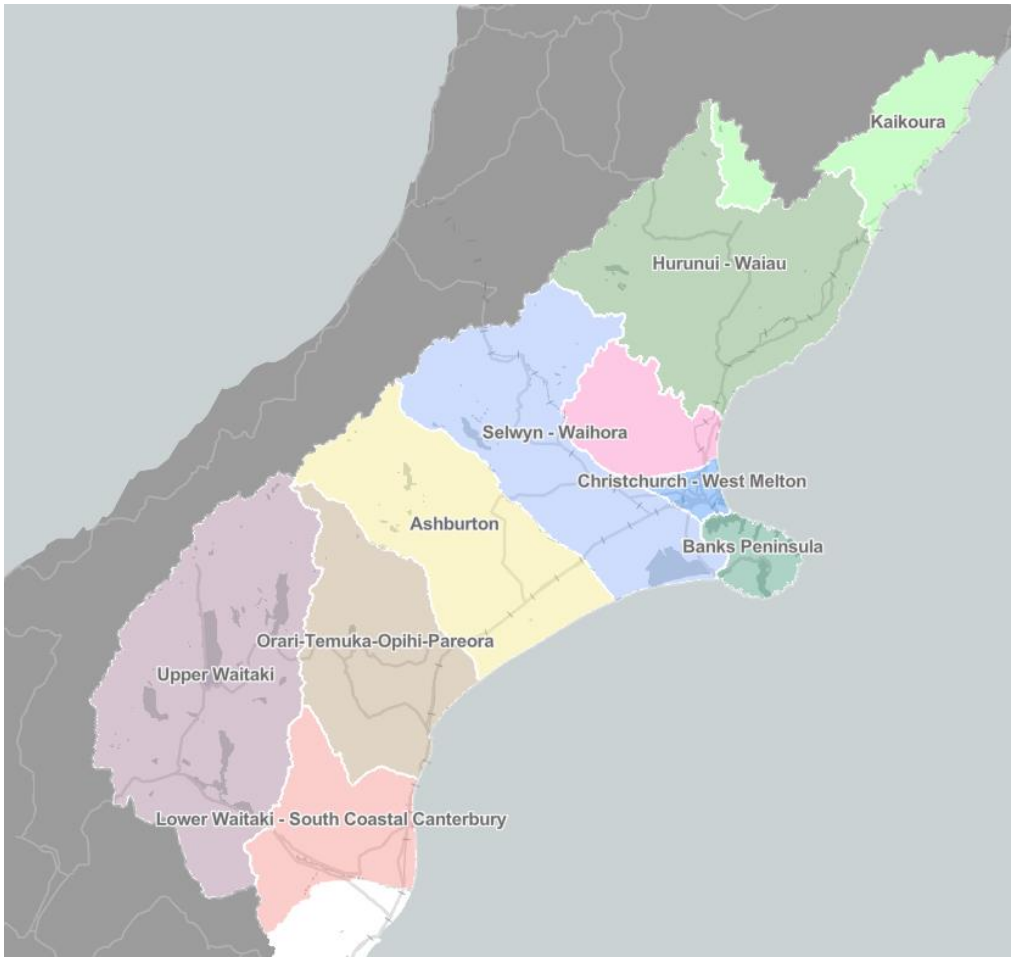


Figure 6. Canterbury Region FEP Zones (Environment Canterbury, n.d.)

Table 6: Animal and vegetation waste (Environment Canterbury, 2020)

Discharge of solid animal waste (excluding that directly from an animal), or vegetative material containing animal excrement or vegetative material	• Does not contain hazardous substances or waste from a human effluent treatment process • Is not discharged onto the same area more frequently than once every two months • Is not discharged where a previous application is still visible or where the soil moisture exceeds field capacity • Is 20m from a bore (used for water abstraction), a surface waterbody (not listed in schedule 17) or the Coastal Marine Area • Is 50 m of a surface waterbody listed in Schedule 17 • Not within a Group

As shown in the FEP, the plan is all about regulating agricultural activities to minimize the negative effect on the natural environment. Farmers are required to follow the guide to achieve good management practice to solve their environmental issues on their properties and is easy and clear for farmers to understand. On the other hand, it has opportunities for further development.

- FEP can be integrated with new farm management planning tools for soil, water, fertilisers, biodiversity and nutrients (Blaschke & Ngapo, 2003). New aspects can provide fresh technology and theory for better farm planning.

- The standard to apply the FEP is different for different regions, which draws dissatisfaction from farmers. For the Hurunui Waiau zone, compulsory auditable farm plans were introduced with the one-size-fits-all approach. This approach left hundreds of farmers non-compliant (McFadden, 2018). It is suggested that the incorporation of FEP with other environmental standards and regional policies could be considered.

- Some farmers found their private information was leaked and used without their permission (Mcfadden, 2018). Even though privacy was not mentioned in any government report, it is necessary to consider anticipated as lacking private information protection will decrease the trust of farmers to concil and affect their motivation to carry out the audit.

2.4.4 The Canterbury Region Farm System

Canterbury has the largest amount of agricultural land with approximately 20% of NZ's farmland. The region consists of a diverse mix of extensive beef and sheep farms on high country, to intensive dairy, beef, sheep, and cropping on the Canterbury plains. Dynes et al. (2010) reviewed the Canterbury farming systems in relation to land use, inputs, and production.

- Dairy Production

Dairy farming in the Canterbury region has expanded rapidly. However, constrained by irrigation water availability, future expansion into dry areas has slowed down. The dairy production in the Canterbury region has large inputs of supplementary feed, irrigation system, and wintering cows off the milking platform (Dynes, Burggraaf, Goulter, & Dalley, 2010). With the increasing need for dairy products in the global market, many cropping and long-established sheep families have converted to or sold their farm for dairying, and share-milking has increased the movement of these farms both in and out of the Canterbury region. Dairy farming has many positive impacts for Canterbury especially on employment, rural economy, regional towns exploration as well as the completion of basic public infrastructures. The energy flow and production process of the dairy farm are shown in Figure 7. In Fengshui, the energy in the dairy farm lays the foundation of "Qi" in the farm. Grazing manure, pasture, cows, silage, and housing need sun to provide sunlight and heat. Pasture, soil, silage, and cows need wind and water to support living and function. "Qi" is involved in every part of the farm to

regulate the flow of energy. Figure 8 is a hypothetical layout of the dairy farm which shows the configuration of each zone.

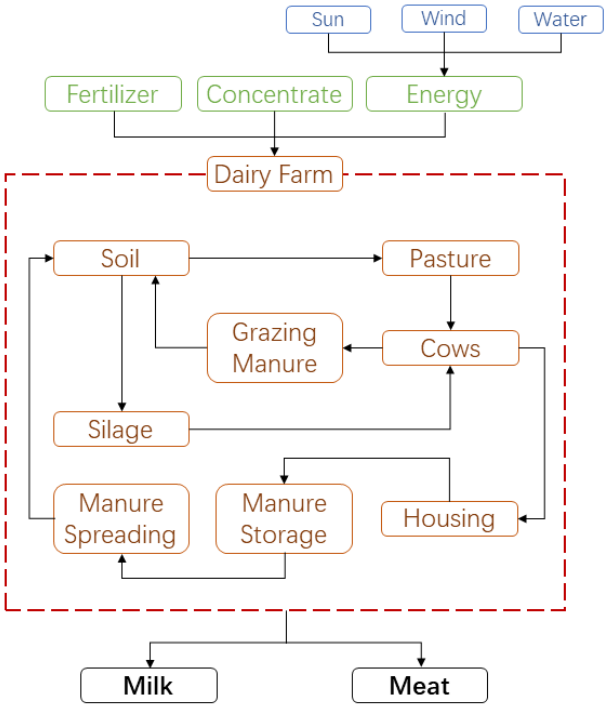


Figure 7. Energy flow in dairy farm (Dynes, Burggraaf, Goulter, & Dalley, 2010)

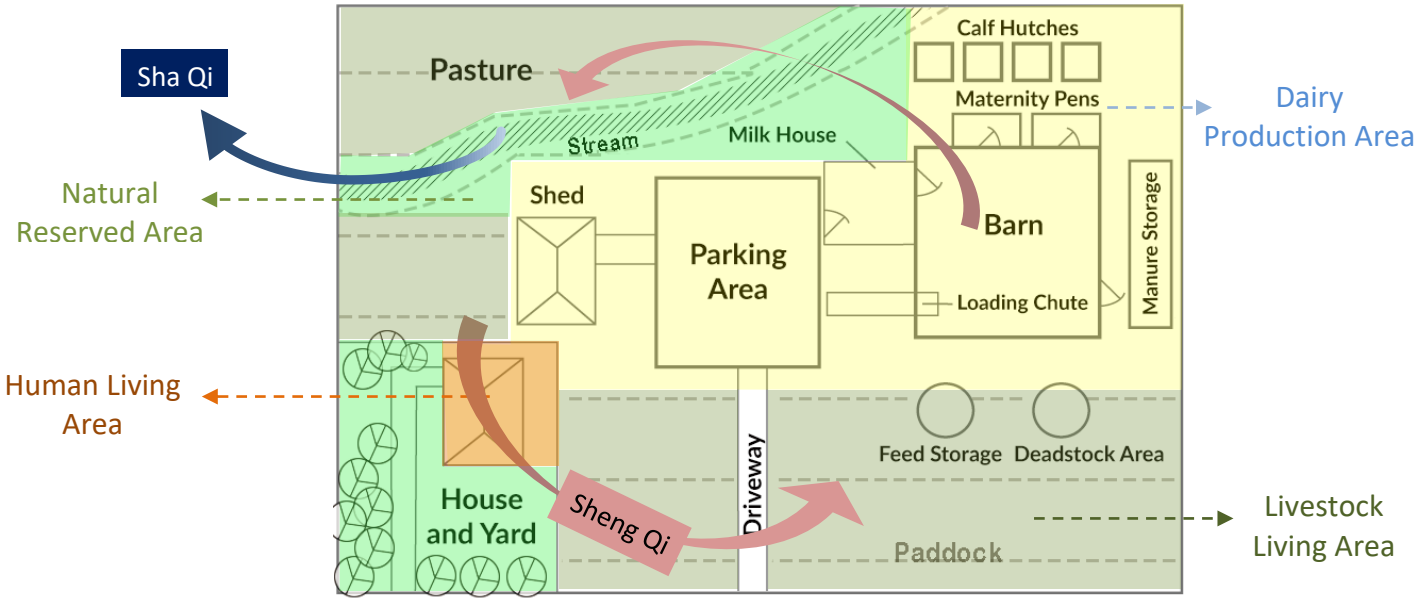


Figure 8. Hypothetical dairy farm layout and "Qi" circulation(Horwitz, 2011)

- Organic Farm System

This is a type of integrated farm. The integration is both in the farm and between farms on a seasonal basis to keep the balance of the feeding production and to maximise the productivity on farm. The land use of each farm can be dynamic and strongly influenced by the relative profitability. The energy flow and production process of the dairy farm are shown in Figure 9. Sun provides solar energy for crops to grow. Wind direction and velocity have significant influences on crop growth and contribute to photosynthesis rates and benefit the nitrogen concentration of

plants (TNAU Agritech Portal, 2016). Rain provides most of the water for vegetables. The rainwater that is not absorbed by plant roots and soil runs into streams. As shown in Figure 10, in Fengshui, the wind, sun, and water have direct influence on crops in the plots, and the thriving vegetation and the flow of energy create “Sheng Qi” on the site. Then, the water will carry the “Qi” and flow out of the farm. These steps shows a healthy “Qi” flow process in the farm. In recent years, the integration of the farm support industries has been connected to dairy production. To ensure consistent high-quality feeds onto the milking platform over winter, dairy farms require cooperation with crop farms. Figure 10 shows the hypothetical layout of the organic farm.

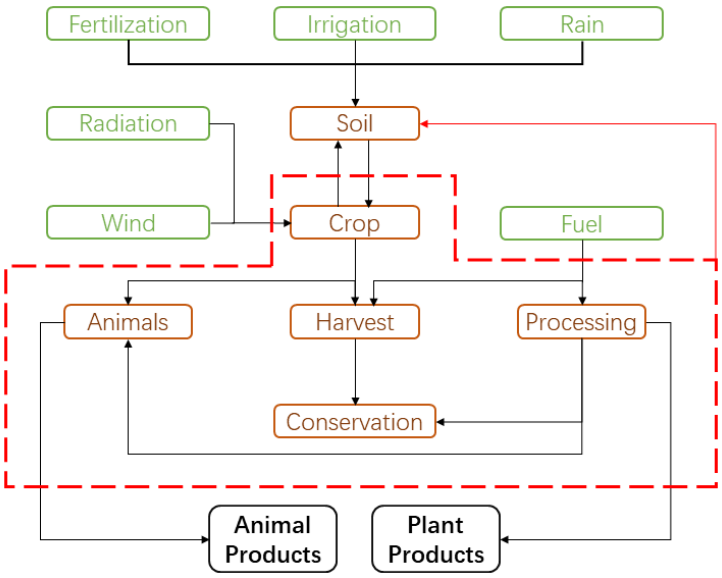


Figure 9. Energy flow in the organic farm

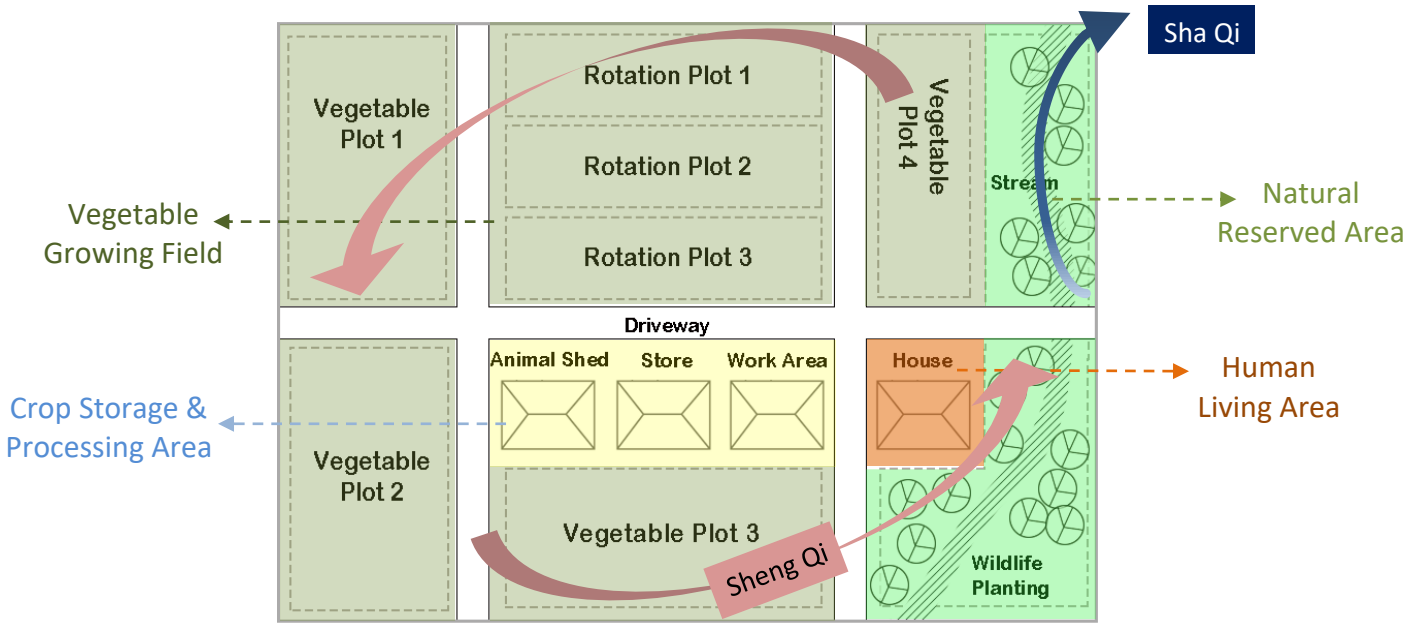


Figure 10. Hypothetical organic farm layout and “Qi” circulation (Chong, 1979)

- Extensive Sheep or Beef Farming

The extensive farming is based on Merino sheep and fine wool production located on tussock grasslands or semi-improved pasture. The average lambing percentage is low but top-performing properties are weaning 125% (Dynes, Burggraaf, Goulter, & Dalley, 2010). Limited by the steep landform, high country farms in the Canterbury region run fine wool, crossbred, or mid-micron sheep according to the class of country. The current land use on an individual high-country farm is a function of various factors, including relative profitability, farmer preferences, balancing risk and availability of the farm resources. The energy flow process of the extensive farm is shown in Figure 11. Similarly to the dairy farm energy flow process, as shown in Figure 12, the "Qi" flows through the site carried by water and wind, it affects the living experience of both human and livestock on the farm. "Sha Qi " can be carried out following the stream.

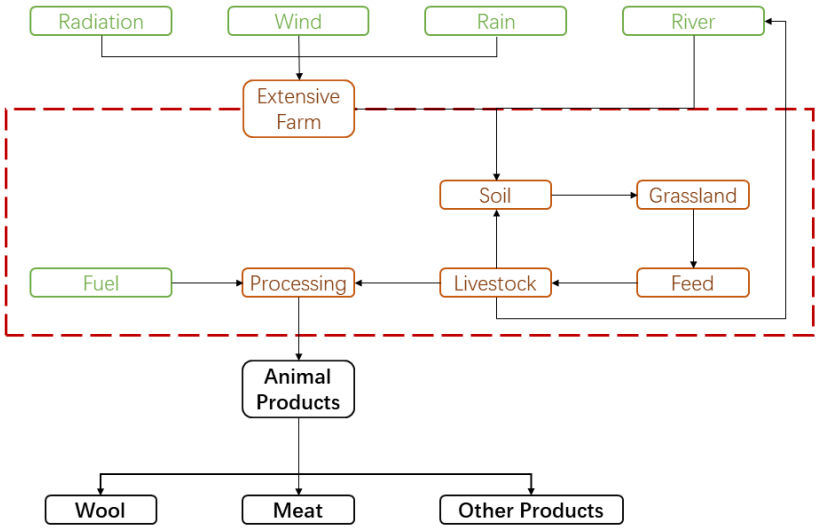


Figure 11. Energy flow in the grazing farm

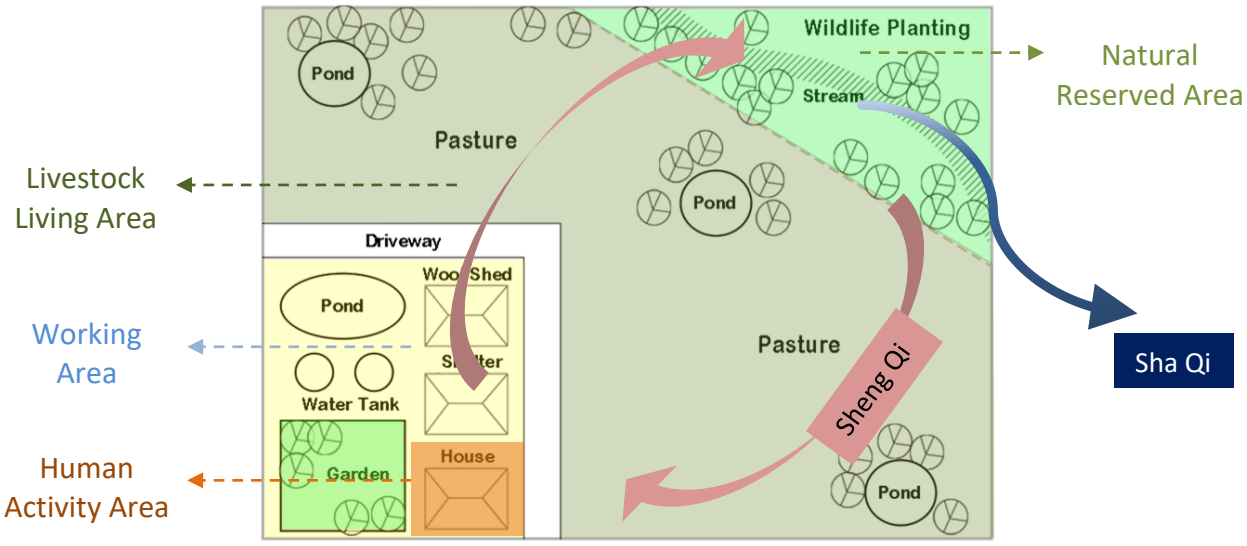


Figure 12. Hypothetical dairy farm layout and "Qi" circulation (Salatin, 2017)

This study combines Fengshui principles from 2000 BC with ecological principles, a meeting of an ancient Eastern and a modern Western approach, to design the site layout for farms according to Han's (2001) analysis. Even though landscape ecology has influenced the New Zealand agricultural landscape for many years since 1990s, the existing landscape is still facing many environmental challenges like the water quality issue, flooding, soil erosion, greenhouse gas emission, and biodiversity loss. As both the farmers and governments are seeking solutions to mitigate these issues, Fengshui has a chance to test whether those concepts can provide a new insight for New Zealand or not. In this research, the following question will be studied and answered:

- What are the existing environmental conditions of the selected farms within the Canterbury region?
- What are the existing opportunities and challenges of the selected farms?
- Is it possible to apply Fengshui principles by sitting proposed farm elements like new plantings, tracks, waterbodies, to regulate the circulation of “Qi” on the farm?
- What are the perceptions and potential of the Fengshui principles compared with landscape ecology in farm planning for the New Zealand agricultural landscape?

Chapter 3. Methods

3.1 Methodological Approach

This study was inductive research that aimed to use Fengshui principles in conjunction with landscape ecology principles as a lens to view farm design to make a contribution to improve the environmental footprint of three farms in the Canterbury region.

This was a descriptive case study research that involved collecting and analysing non-numerical data to understand the landform, farm layout, flow of wind and water, plant growing conditions, as well as human and wildlife living habitats of the farms. The research data (including photos, videos, audio, etc.) were collected primarily from the three farms in the Canterbury region. This study also included secondary data from websites, including geographical information and the related regional regulations.

As a case study research, the three farms were chosen purposely based on their landforms (refer to section 2.4), environmental conditions (refer to section 2.4.1), and farm systems (refer to section 2.4.4). For each farm, all the timescales, study areas, and viewpoints were set before the data collection to ensure validity and reliability. The data of the site were collected at a single point in time during the site visit, including the site environmental conditions, landforms, and experience. The farm layout redesign was simulated on a desktop of the tested hypotheses.

Figure 13 shows the overall structure of the research:

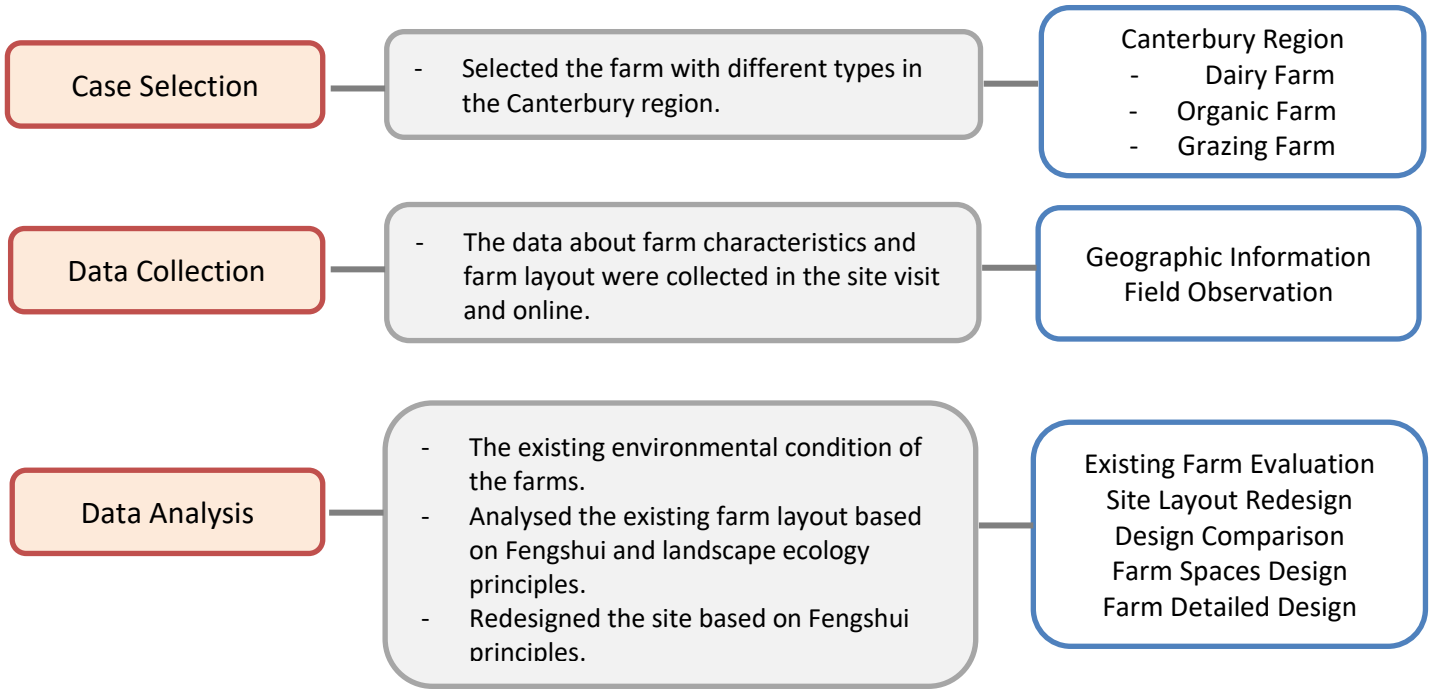


Figure 13. Research structure

3.2 Study Site Context

In this research, the case study farms were selected from the Canterbury region in New Zealand. Detailed site selection criteria were introduced below.

3.2.1 Canterbury Region

This research focused on farms in the Canterbury region. Canterbury lies on the eastern side of the South Island in New Zealand, with the most extensive flat land in New Zealand from the western foothills to the east coast. The Canterbury region has abundant surface run off or subsurface ground water from the surrounding mountains towards the coast which has been tapped to irrigate the farmland. This project worked in Canterbury due to the dominance of agricultural production on a diverse range of landscapes from hilly areas on the Port Hills and flatland across the Waimakariri flood plains (refer to section 2.4).

3.2.2 Farm Selection

This research aimed to explore whether Fengshui could contribute to the agricultural environment by redesigning the farm layout based on using Fengshui principles. A change of farm layout was a challenge for both humans and non-humans. For different farming types, the farm layout was varied. If Fengshui can be applied to different types of farms, it would prove that Fengshui could be more appropriate for a broader area of agricultural production.

According to Stats NZ (2016), there are 8,034 farms in the Canterbury region. These farms are varied in their type of product and means of production (refer to section 2.4). This research worked with the landscape architect, Dan Cameron, who had been contracted to look at the Farm Environment Plans in ten Canterbury farms to address farm biodiversity restoration. Of those ten farms that he had been asked to work on, five farms were offered for the study of which three farms of different types were chosen. The farming types were dairy farming, organic farming, and grazing farming. The criteria of farm selection were based on the following reasons:

- It was a challenge to apply Fengshui on the three different farming types because each of them had a unique farm layout based on the type of farm system in section 2.4.4 and the surrounding environment.
- For the dairy farming and organic farming, most of them were located on a flat plain while Fengshui was mostly applied in hilly and valley areas. It was a challenge to apply Fengshui on a flat landform that was not the ideal Fengshui landscape.
- The grazing farms were mostly located on a hill slope, on which Fengshui has been mostly applied. It was a chance for this study to apply Fengshui principles on a similar landform from its original Fengshui model.

In this research, three selected farms were characterised by two criteria: landform and farm system. The farm landform could be either hilly landform or flatland. Moreover, the landscape layout design in the production area should be varied based on different farm systems. The farm selection aimed to broaden the application of Fengshui in the farm design by selecting three farms with very different landscape characteristics and production types. Based on the selection criteria, three farms were chosen as case study farms (Figure 14).

Figure 14. The approximate locations of the selected farms in the Canterbury region

These farms were in two districts in the Canterbury region- Hororata and Banks Peninsula. All of these three farms had different farming types and products. The farm types included crop growing, intensive dairy farming, and extensive dairy farming. The approximate forest cover rate ranged from lower than 1% to approximately 9%. The information sourced from other documents about the farm type and its history was also valuable for the research. The background information provided a brief acknowledgment of the spatial relationship of the site to its surrounding landscape. The detailed information of the three selected farms is shown in Table 7.

Table 7. Characteristics of the selected farms

Farm	Location & Area	Land use	Landform	Farm type	Forest Cover	Transportation	Hydrology	Presence of Buildings
1	Hororata 252ha	Grassland	Flat landform on the Waimakariri flood plains	Intensive dairy farming (Milk powder)	<1%	Public road (on one corner of the farm) Private road (through the farm)	Two river channels on north and south sides	Two clusters of buildings on the farm
2	Hororata 138ha	Grassland	Flat landform on the Waimakariri flood plains	Organic vegetation growing	≈9%	Public road (on three sides of the farm) Private road (through the farm)	Three river channels run through the site.	Two clusters of building on the farm
3	Banks Peninsula 174ha	Grassland	Port Hill foothills and gentle slope	Extensive dairy farming	≈9%	Public road (on north side of the farm)	Open ocean on north side of the farm	One cluster of building on the farm

3.2.2.1 Farm 1: Dairy Farm

This farm was located in the Hororata region with a flat landform (Figure 15). It produces milk powder and supplies the primary dealer. The farm was designed to follow the requirements of the Christchurch City Council, especially on the wastewater treatment system and pollutant treatment system. A drainage problem in the rainy season is the key environmental issue of the farm now. Some of the livestock living areas had a waterlogging problem.

Figure 15. Screenshot of an aerial photo of the dairy farm (Canterbury Maps, n.d.)

3.2.2.2 Farm 2: Organic Farm

This organic farm was located in the Hororata region with a flat landform (Figure 16). The farm grows organic vegetables with no agricultural chemicals. It encourages natural restoration on-site, mainly focusing on planting native species. The site is located close to the Hororata River and has a high potential for flooding in the rainy season. The environmental challenges of the farm included a mudfish habitat under threat, a flooding hazard in the rainy season, and biodiversity loss along the water channel. These environmental challenges were the focus of this farm.

Figure 16. Screenshot of the aerial photo of the organic farm (Canterbury Maps, n.d.)

3.2.2.3 Farm 3: Grazing Farm

This was a sheep farm located in Banks Peninsula with a hilly landform (Figure 17). The farm faces Big Bay and Blind Bay. As an extensive dairy farming area, there is minimum intervention on the natural environment on the farm. The landowner aims to protect the outstanding natural landscape on the farm and focuses on natural restoration in the living area. The existing hill slopes have high potential for soil erosion in the rainy season. Moreover, the valley area has a drainage issue when the water amounts increase.

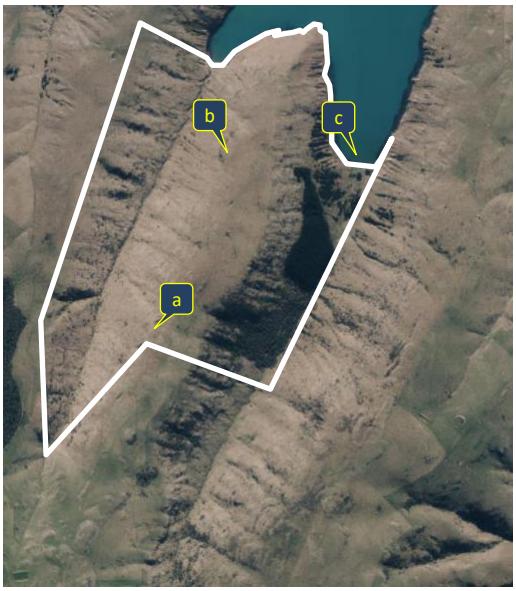


Figure 17. Screenshot of the aerial photo of the grazing farm (Canterbury Maps, n.d.)

3.3 Data Collection

In this research, there were two ways to collect data of each case study farm. The spatial information of site was collected by using online programmes. During the site visit, experimental information from different viewpoints were collected and recorded by photo, audio, and field notes.

3.3.1 Spatial Information of Each Farm

The research used Google Earth and Canterbury Maps as mapping methods to analyse the spatial pattern of the site topographically. The online map programmes provided the geophysical information of the farm's specific location, landform, land use, transportation network, hydrology layout, and presence of buildings.

- Google Earth

  The landscape architect, Dan Cameron, provided the location information and the farm boundary in a KMZ file, which could be opened by using Google Earth on 04 April 2020. Moreover, this research used Google Earth to calculate the farm size and forest cover rate in a background data

collection on 06 April 2020, from https://www.google.com/earth/versions/#earth-pro. The 3D view tool in Google Earth was used to simulate the real landform of the farm for further analysis.

- Canterbury Maps

  Canterbury Maps was used to collect the map of the farm in plan view with an aerial photo base map and approximate scale on 11 June 2020 and 14 June 2020 from https://www.google.com/earth/versions/#earth-pro. The map would be used as the base map for further farm layout analysis and redesign. The mapping data collected from Canterbury Maps could also be used to analyse the land cover and land use of the site.

3.3.2 Field Observation from Multiple Viewpoints

The real experience on the site helped to collect the primary information and required using multiple senses. The research visited the site between July 2020 and August 2020. Each farm was visited once. Limited by the time of the research and the weather, for each site visit, 2-3 hours were spent in the field and three to five viewpoints were selected for each farm based on the road accessibility and landform.

For the dairy farm in Hororata, four viewpoints were selected (Figure 15): (a) at the residential area looking south; (b) at the bank of the water channel looking west; (c) at the office looking at the surrounding environment; (d) at the east boundary near the Hororata river looking northeast. Instead of the observation on the selected viewpoints, photos were taken sequentially along the driving route from the entrance at the east side to the west boundary.

For the organic farm in Hororata, five viewpoints were selected (Figure 16): (a) at the restoration area in the south part of the farm facing to the east; (b) at the road of the residential area facing to the southwest; (c) at the mudfish living area facing to the south; (d) at the bank of the water channel in the middle of the north farm; (e) at the public road on the north side of the farm facing to the south.

For the grazing farm in Banks Peninsula, three viewpoints were selected (Figure 17): (a) at the entrance of the farm facing to the east on the hill ridge; (b) at the middle of the public road on the ridge facing to the north; (c) at Big Bay facing to the north and south. More photos were taken sequentially along the walking track at the bottom of the Big Bay valley.

During the site visit, the information that had been seen, heard, or encountered needed to be recorded. The following three major parts were observed and recorded.

- Farming and production areas

At the farming and production areas, the site visit recorded the number of plants, plant density, any potential hazard, livestock behaviour, site layout, and the spatial relationship with the surrounding natural environment.

- Residential area

  The observation of the residential area recorded the environmental condition of the living area and its surrounding environment, including water, trees, road, sunlight, and wind. Moreover, the configuration of the house was recorded.

- Reserve area

  The observation of the reserve area mainly focused on plant growing condition along the waterway of the site. Moreover, it focused on the water quality and speed of the stream or water channel. The site visit recorded the farm layout of the site and the pattern of the landscape features.

The activity on the site should not disturb the natural environment or intervene in the production process. There were four types of data that were recorded and documented during the site visit.

- Fieldnotes

  Fieldnotes were prepared before the site visit, which listed all the relevant information collected on-site (Appendix 2). During the site visit, the information in the field notes would be recorded. The field notes were used to record the natural information that could mostly be shown by words and simple diagrams. The field notes included: wind (direction and strength), water flow direction, building configuration, landscape patterns (patch, corridor, and matrix), time, and sensory feelings like smell and touch. A simple diagram of the site could provide an intuitive acknowledgment of the spatial relationship of the farmland with its surrounding environment.

- Photographs

  It was essential to take photos on the site to record the detailed visual information on site. For the dairy farm and organic farm, photos were taken by iPhone 8 with a 12MP camera. For the grazing farm in the Banks Peninsula, there was only one road on the hill ridge. To record the detailed landscape information clearly, the site visit selected the NIKON D3300 camera which had higher resolution when taking photo from a far distance to take photos and record visual data on the site. Selected focal lengths were 18mm, 35mm, 50mm, 70mm, 90mm, 120mm, or 150mm as appropriate.

  The landscape environment, landcover pattern, farm layout, and relationship with the surrounding environment were reflected in photos. The photos were taken through the whole process of the site visit. The photography could be taken from different scales to record different

information. For large scale, the photographs were taken to record the relationship and spatial layout of the environment. For detailed scale, the photographs were mainly used to collect detailed data like the leaf colour, soil moisture regime, and livestock behaviour, etc.

- Videos

  During the site visit, video data could record the real-time sequential experience of the site. This tool combined photography and audio and recorded the naturally occurring data.

- Audio

  The audio recording collected the information that was not able to be collected visually. The researcher would use a phone to do the recording during the site visit. Audio data aimed to record the information when walking with Dan Cameron as he provided a detailed introduction to the farm especially on the environmental condition and existing potential issues.

3.4 Farm Interpretation Process

This research used the existing farm's spatial information collected from mapping tools and site visit to represent the current landscape design by using simple diagrams on the plan. Diagrams were used as a tool to compare and critique its landscape design by using both landscape ecology principles and Fengshui Principles. They could help to analyse the similarities and differences in the landscape ecology approaches and Fengshui principles, reading the Canterbury region farmland design in a new and different way and provide insight into Canterbury's region farmland design. Figure 18 shows the farm interpretation process.

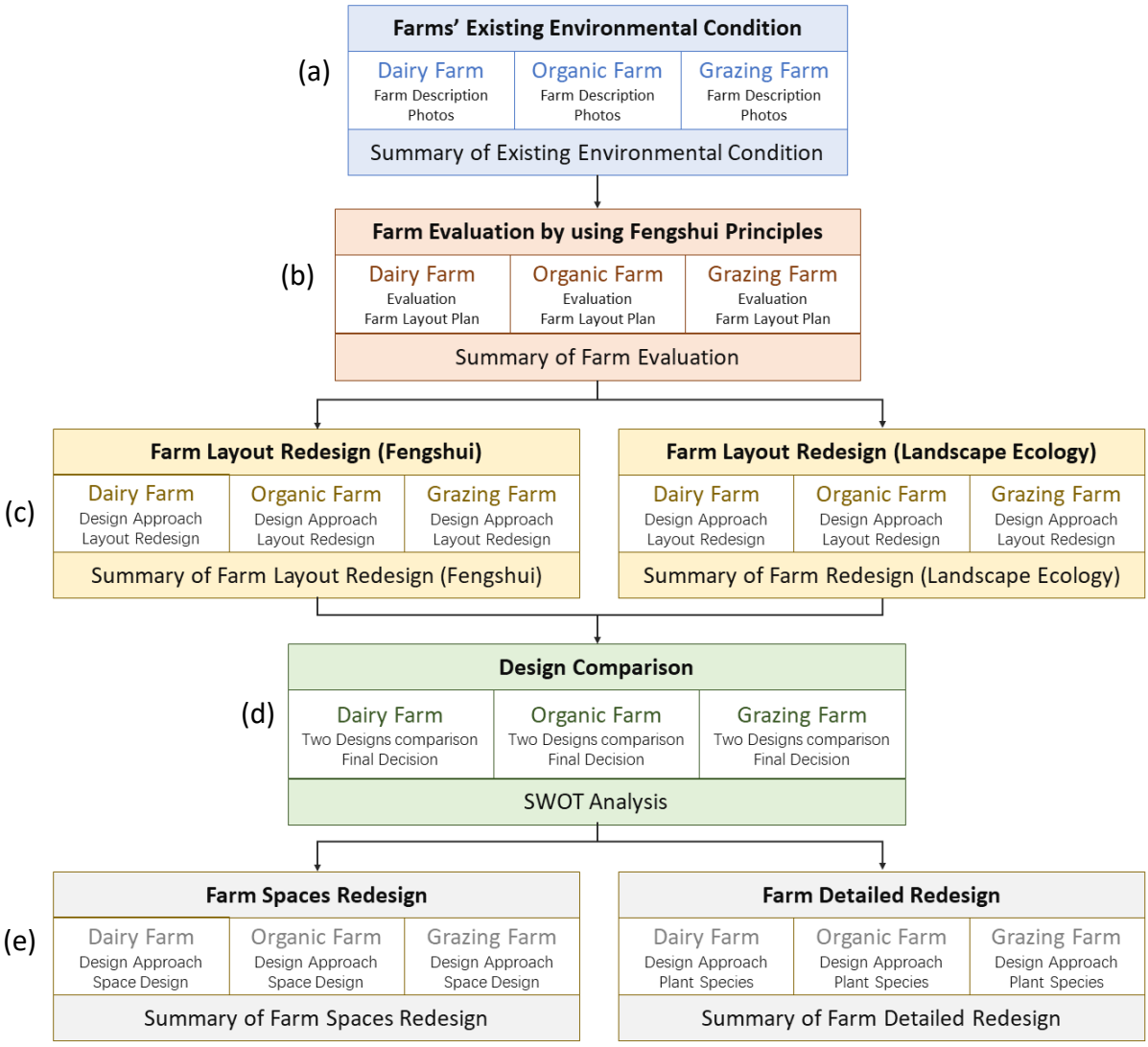


Figure 18. Overview of the redesign process

3.4.1 Farm Characteristics

Farm description was step (a) in Figure 18. Based on the landscape elements that listed in Table 5, the research described the character of each landscape feature of the farm including water, soil, plants, structures, and road. Moreover, the surrounding environment was included in the farm character analysis. According to the collected data from the internet and the site visit, the research described the overall natural environmental condition, farm location and existing environmental

issues on the site (refer to section 2.4). The character description provided a brief introduction to the farm. Moreover, photos were collected and sorted.

3.4.2 Farm Interpretation

Farm interpretation was divided into two parts. The first part of the farm interpretation was to use Fengshui as a lens to read the farm layout. It analysed the overall farm layout based on the flow of "Qi". It introduced and analysed the condition of the "Qi" flow of the farm and its related landscape features. Site layout drawing was needed to support the site interpretation. The second part was to analysis the farm layout by using landscape ecology and Fengshui principles separately. This was the step (b) in Figure 18. The description was divided into five aspects: landform, vegetation, water, buildings, and road. The study scored each aspect from 0 to 4 (Table 8). The comment explained the score and described the current landscape characteristics. The research hence provided proposed changes by using Fengshui and landscape ecology principles based on the score. Table 9 shows the examples of site inventory and analysis. By comparing the score, combined with the interpretation by using Fengshui principles, this research will analysis the variations and similarities of site interpretation by using the landscape ecology and Fengshui principles.

Table 8: Scoring table

Score	Description
0	The existing farm layout is not relevant to the criteria
1	Some parts of the design meet the ideal principles
2	Half of the design meets the ideal principles
3	Most parts of the design meet the ideal principles
4	The design totally meets the ideal principles

Table 9: Farm layout inventory and analysis example

	Description	Landscape Ecology	Suggested Changes (Landscape Ecology)	Score	Fengshui Principles	Score	Suggested Changes (Fengshui)
Landform	A relatively flat farm. The site is located on the Canterbury plain. Only the North and West sides of the farm are surrounded by mountains in the far distance.	Wind erosion control can maintain vegetation and control streamline airflow.	Plant a continuous shelterbelt around the site especially on the south side to block the wind.	2	An ideal Fengshui location is a semi-enclosed space for farmland.	3	If the site is too flat and lacks large mountains, vegetation like a Fengshui Forest can remedy the imperfect landscape.

3.4.3 Farm Redesign

Based on the suggested changes in Table 9 as an example, the farm redesign was divided into three parts: farm layout design, detailed space design, and detailed plant selection. The redesign covered steps (c), (d) and (e) in Figure 18. The redesign aimed to improve the environmental condition of the farm, especially on the existing issues and potential natural hazards. The priority requirement of the

redesign was to respect the local culture and the existing natural environment. The redesign focused on different scales of the farm, from the whole farm layout to a detailed function zone. Farm layout design focused on the spatial arrangement of the landscape features of the farm in a large scale. The design included changing the shape, size, direction, amount, and location of landscape features like waterways, native plants, roads, and buildings. The farm layout redesign was discussed and compared by using Fengshui principles and landscape ecology principles. The detailed scale space design showed how each landscape feature co-operated in a specific area like the milk production zone, natural restoration area, and residential area. The detailed plant selection provided a direction about how to select suitable plants on the farm.

3.4.3.1 Farm Layout Redesign

The farm layout redesign was divided into two parts. The first part was step (c) in Figure 18. The farm layout was redesigned separately based on two different design principles, Fengshui and landscape ecology. The redesign started from the overall farm layout which was based on the Fengshui principles. The topographical plan could show the spatial arrangement of main physical features on the ground such as: river shape, shelterbelt, road, and building location, etc. The plan was used to show the redesigned layout of the whole farm. The design concept was explained based on Fengshui principles. Assisted by the landscape architecture, Dan Cameron, this research redesigned the farm layout based on the landscape ecology principles. The topographical plan was drew by using the same style and colour code as the existing site drawing, which was comparable.

The design comparison, as shown in step (d) in Figure 18 aimed to compare the two redesigns based on Fengshui principles and landscape ecology. By critiquing the design from Dan Cameron by using Fengshui principles, whether the redesign and solution using the Fengshui Principle were similar to the suggestion provided by the qualified landscape architect, Dan Cameron, was discussed. Also discussed were whether the suggestions by Dan Cameron were different and the function of the strategy and its effect on the surrounding landscape. Based on the discussion, approaches to the final redesign were decided. The final redesign of the site was based on the comparison. It combined the strength of both redesigns and achieved the most benefit for the farm environment.

Based on the inventory and analysis, the differences and similarities of landscape ecology principles and Fengshui principles, when regulating the orientation and location of different elements on the farmland, were compared. It was concluded that, through the similarities, it would be discovered which part of the environmental plan in the Canterbury region was the same as the regulations in the Fengshui principles.

3.4.3.2 Farm Detail Redesign

To explain the design approach clearly, detail ed design was also included. The redesign is referred to as step (e) in Figure 18. The application of Fengshui principles was different compared with the

overall farm layout redesign. For each farm, this research selected two representative places to explain the detailed Fengshui approaches, one explained the spatial arrangement on a detailed scale, the other discussed the plant selection. The selection of the location was based on the environmental condition and design goal of each farm. The detailed design was divided into two parts: space redesign and planting area redesign. To better explain the design approach and concept, the space redesign used Lumion as a visualization tool to simulate the spatial layout of the design area, while the planting area selected photos and sketching to explain the plant selection ideas.

- Space Design

  The detailed space design focused on the spatial layout design based on Fengshui principles. It selected three different types of function area in the three selected farms which were, production area, natural restoration area, and living area. These three areas were the common zones that each farm had included in the hypothetical farm layout as shown in Figure 8, Figure 10, and Figure 12.

  This research used Lumion to simulate the design in a relatively real visual expression. For this research, Lumion and Sketch Up were selected as tools to bring the design to life and show it in a detailed, captivating environment. Moreover, this kind of realistic visualization could show the dynamic change of such elements as water level and shadow. The 3D diagram was used to reflect the relationship between structure and its surrounding natural environment. The diagram could choose the human viewpoint and viewing angle to simulate the experience when looking at the design in a three-dimensional effect.

- Plant Selection

  This detailed scale design focused on the plant species selection and spatial arrangement of plants with different environmental conditions based on Fengshui principles. For the detailed planting area three farms were selected with different environmental conditions: flooding, waterlogging, habitat loss, and soil erosion. The design explained how Fengshui would be applied under specific environmental conditions.

  This visualization tool selected the photo data collected from the site visit and redesigned by sketching. The design used photo and sketching as a comparison to better explain the before and after of the selected site. Sketching on the photo was an efficient way to help understand the design intention in a real background. Photo sketching was a visualization tool that involved drawing on the photo by using white lines to show the design based on the existing landscape.

Chapter 4. Results

4.1 Existing Farm Characteristics

The character of the dairy farm, organic farm, and grazing farm were described separately including water, soil, plants, structures, and road. The surrounding environment and its environmental condition was also included as below.

4.1.1 Dairy Farm

The site visit to the dairy farm occurred on 3rd July 2020. The data from the site visit was collected and was shown in Appendix 2. The farm was flat and tilted to the southwest as the river flow direction. The major land cover on the site was pasture for cows. At the regional scale, the closest hill was Malvern Hills on the west side of the site. Strong wind flowed from north side of the farm.

- Water

  The farm was adjacent to the Hororata River (Figure 19). In the farm, there was a water channel which flowed through the middle of the farm from north to south. Water flowed from north to south. The farm had an issue with waterlogging in the rainy season. After the 2012 earthquake, the site landform had changed. Some parts of the landform had lifted and the owner had to raise the road to ensure the connectivity of the road system in the fracture zone. This caused the waterlogging issue on the flat land. The lifted landform affected the drainage ability of the farm (Figure 20).

- Soil

  The farm was located on the alluvial fan near the Hororata river. The soil was thin covered loess planted in pasture. The soil was dry in summer and cold in winter and early spring. The farm used a pivot for irrigation through the whole livestock living area.

- Vegetation

  There were three main types of vegetation on the farm: shrub, grass, and shelterbelt trees (Figure 21). The livestock living area was covered by grass which took up over 90% of the farm. The shrubs on the site were mainly located along the river and around the house. The flax and shrub along the river were planted for water filtration and soil consolidation, while the shrubs around the house were just for decoration. The trees on the site were treated as a shelterbelt, and used to buffer the strong wind. The farm had no area of native habitat except the water channel area.

- Structures and Roads

There were three major types of structures: office, milk production structures, and residential houses (Figure 22). The office and milk production structure area were located together as an industrial group. The residential house was located at a distance from the industrial group. There was a single road connecting the residential area and the milk production area adjacent to the water channel in the middle of the farm.

Figure 19. Farm boundary adjacent to Hororata River

Figure 20. Photos of the waterlogging problem on the road (left), grassland (middle), and the farm boundary (right)

Figure 21. Photos of the shrub along the river (left), around the house (middle), and the shelterbelt trees (right)

Figure 22. Photos of the office (left), milk production structure (middle), and the residential house (right)

4.1.2 Organic Farm

The site visit to the organic farm occurred on 31st July 2020. The data from the site visit was collected and shown in Appendix 2. The landform of the farm was flat and tilted to the southwest (Figure 23). The major land cover on the site was organic vegetables and grass. On the regional scale, the nearest hill was the Malvern Hills on the northwest side of the farm. The wind flowed from north to south.

- Water

  As shown in Figure 23, there were several water channels flowing through the site. The branch on the north side of the farm was a fan shape, then it merged into one stream in the middle of the farm. The farm owner designed the water channels purposely to protect the farm from flooding or drainage issues especially on the south part of the farm. The water channel had seasonal water which flowed from north to south. Based on observation from the site visit, the existing water channel was dry. The width of the water channel was around 2m wide and 1m deep. During the dry season, there was a stretch of water channel which had stagnant water and was divided into a pond. The moist mud, comfortable temperature, and stopped water provided a perfect habitat for local mudfish (Figure 18) which lived in a tiny pond with little water. The plants along the water channel were lack of maintenance. The south part of the farm had high flooding potential in the rain season especially for the existing restoration project area.

- Soil

  The farm was located on the alluvial fan near the Hororata river. The soil of the farm was rich in nutrients with black colour which was perfect for plant to grow. This organic farm did not use any fertilizer on the ground to grow vegetables.

- Vegetation

  The landowner was keen to enhance the natural restoration by planting indigenous species on the farm. There was a large patch of native forest next to the water channel close to the living area. The proposed natural restoration area was located on the south part of the farm, close to the water channel (Figure 25). This year, the landowner removed several exotic willow trees along the water bank. Along the self-designed water channel area, the native plants were less cared for a low survival rate (Figure 25).

- Structure and Road

  There were two types of structures on site: tool sheds and residential houses (Figure 20). Apart from one dwelling located on the south part of the farm, other buildings were located close to the restoration area on the north part of the farm. These buildings were standing in line and facing to the south. The road in the middle parted the farm which disturbed the connection of

the native habitat. The overall layout of the road was designed following the water channel which was unsealed.

Figure 23. Photos of tilted landform and the vegetation in the field

Figure 24. Photos of the water channel in the south part of the farm (left), north part of the farm (middle), and the mudfish pond (right)

Figure 25. Photos of the restoration project (left), and the plants along the water channel (right)

Figure 26. Photo of the sheds and road

4.1.3 Grazing Farm

The site visit to the grazing farm occurred on 21st August. The data from the site was collected and shown in Appendix 2. The major landform of Banks Peninsula is volcanic cones. This farm was located on the Mt Herbert Volcanic Group, which included multiple landform types – hill, valley, and bay (Figure 27). The farm had two valleys and one hill ridge in between, facing and tilted to the northeast bay area. The valleys extend to two bays in the farm – Blind Bay and Big Bay. These two bays were adjacent to each other and formed two u-shaped bays. Determined by the geomorphological process, the farm area was covered by loess soil which is prone to be eroded.

- Water

  This farm had two valleys which followed the landform. Each valley had a lowland stream that flowed from the bottom of the inner valley into the sea. Several tributaries flowed down the hill into the stream. There was a stream which flowed through the side of the residential area and went into Big Bay. The water level changed greatly in seasons. In winter and autumn, the water channel was dry. In the rainy season, the rainwater flushed down from the hill slop and gathered around the woolshed area with a drainage problem.

- Soil

  The soil on the slope was stony or eroded soil types which had a thick cover of loess. The elevated landform and soil type intensified the effect of the water on soil erosion (Figure 28). For the slope areas with bare plants, the soil erosion issue in the rain season was more distinctive.

- Vegetation

  The major landcover types of the farm were grass, tussock, pine trees, and indigenous bush and shrubs (Figure 29). The grass and tussock covered most of the upper hill area. The pine forest was a large patch of forest with a clear boundary planted by settlers several years ago. The indigenous bush and shrubs were located along the bottom of the valley and spread to the upper hill slope in several patches.

- Structure and Road

  The buildings were located at the foreshore area of Big Bay (Figure 30). There were three buildings on the farm – the holiday house at the beach, the abandoned woolshed at the foothill, and the living house at the watergate. The only road on the farm was an unsealed driveway on the hill ridge which extended to the Big Bay living area.

Figure 27. Photos of the hill (left), valley (middle), and bay (right) landform

Figure 28. Photos of the stream in the dry season (left) and eroded hill slope (right)

Figure 29. Photos of the landcover- grass (upper left), tussock (upper right), native bush (left bottom), and pine forest (right bottom)

Figure 30. Photos of the manmade structures- holiday house (upper left), woolshed (upper right), residential home (left bottom), and unsealed road (right bottom)

4.1.4 Summary of Existing Farm Characteristics

Even though the three farms had different products and agricultural production systems, their infrastructures and environmental issues were similar. The key infrastructures on the site were residential dwellings, industrial sheds, and roads. The existing environmental issues included a drainage issue, flooding, soil erosion, and native habitat degradation (Table 10).

The dairy farm and the grazing farm had drainage issue s for different reasons. The dairy farm's waterlogging was caused by the flat landform and an uneven landform after the earthquake. For the grazing farm, seasonal rain and low drainage soil were the main reasons for the drainage problem.

The flooding issue and seasonal water level change had affected the surrounding habitat on the organic farm and grazing farm. For the organic farm's south part, when the water level increased, it could affect nearly 50% of the south part of the farm. In the dry season, lack of water meant it was hard for the plants along the channel to survive.

Soil erosion was the major issue for the grazing farm which was located on a hilly landscape. As the other two farms were located on the Canterbury Plains area, the soil on the flat landform was not prone to erosion.

The dairy farm was lacking in biodiversity because over 90% of the area was covered by grass for livestock needs. On the other hand, all the three farms' landowners were willing to achieve natural restoration to protect the native habitat. The landowner of the dairy farm aimed to create a comfortable living environment for livestock while mitigating the biodiversity loss problem by achieving natural restoration. The landowner of the organic farm was willing to create a comfortable habitat for mudfish and enhance natural restoration around existing forest area at the same time. The grazing farm only focused on the natural restoration of the Big Bay valley. The sheep living environment was not considered.

Table 10. Environmental condition of the case study farms

Farm	Drainage Issue	Flooding	Soil Erosion	Biodiversity Loss
Dairy Farm	√	×	×	√
Organic Farm	×	√	×	○
Grazing Farm	√	×	√	○

√: The farm had this issue

×: The farm did not have this issue

○: The farm did not have this issue, but the landowner was willing to achieve natural restoration

4.2 Farm Layout Interpretation

According to the site characteristics, the farm layout interpretation used Fengshui as a lens to analysis “Qi” flow on each farm. Moreover, it analysed the farm layout by using landscape ecology and Fengshui principles separately.

4.2.1 Dairy Farm

The landform was too flat to gather “Qi” on the site. At the regional scale, the farm was lacking protection from the “Green Dragon”. Only the “White Tiger” side of the farm was surrounded by the mountain in the far distance. Moreover, the site was affected by “Sha Qi” for two reasons. The farm was not protected by a buffer to slow down the speed of wind and preserve “Sheng Qi” on the site. The farm was lacking thriving vegetation which meant “Sha Qi” could easily affect the farm. In Fengshui, drainage issues and biodiversity loss were caused by the presence of “Sha Qi”. Without thriving vegetation on the farm, logged water could not be absorbed by plants. At the macroscale, the vegetation along the water channel was too short, while the water channel was too narrow to form a systematic ecosystem. The detailed analysis of the site was shown in Figure 31.

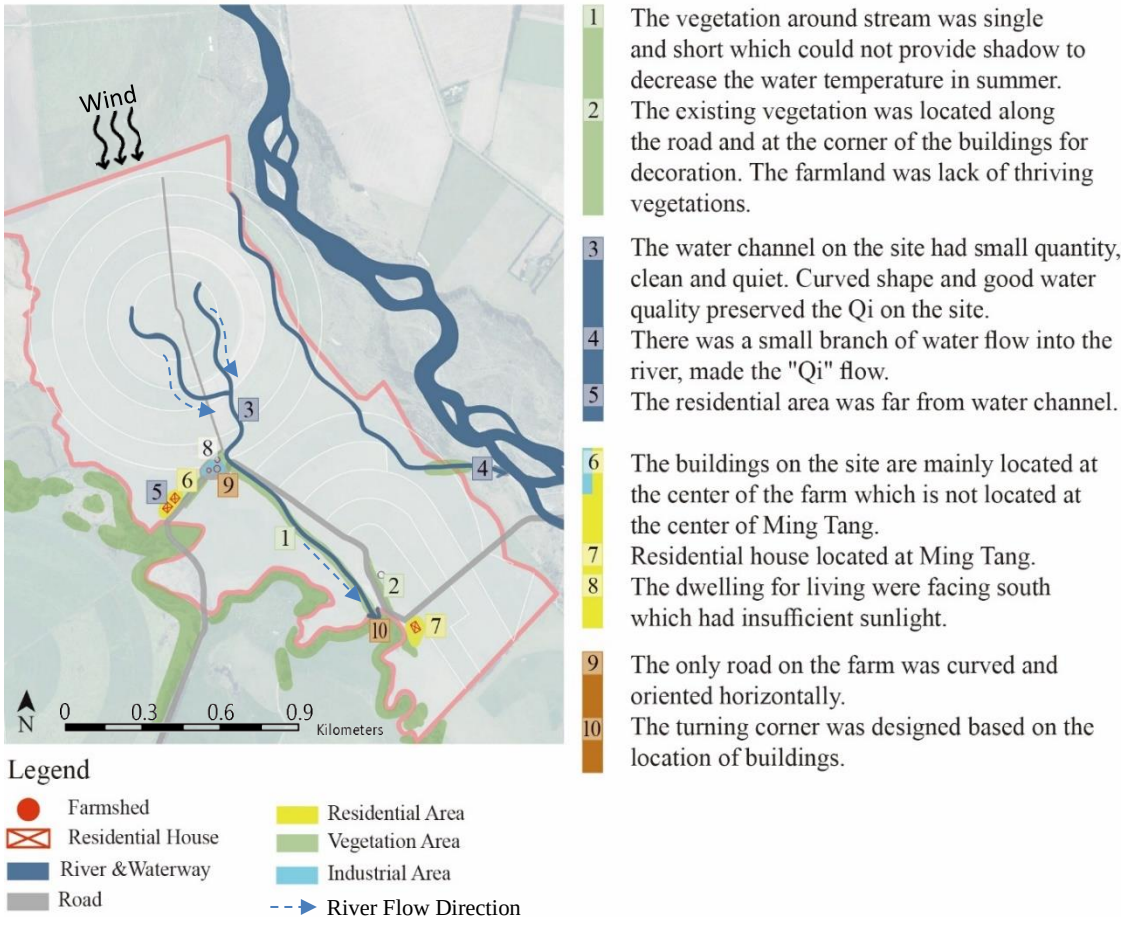


Figure 31. Dairy farm analysis

The site inventory and analysis of the farm layout based on Fengshui and landscape ecology were shown in Table 11. The score in the table showed that the analysis of the natural landscape features

like wind, water, and vegetation had a similar score based on landscape ecology and Fengshui principles. The variation arose from the analysis of the building and road structures of the farm by using these two principles. Landscape ecology focused on protecting the integration of the natural habitat which minimized the disturbance to the surrounding environment, while Fengshui emphasised the experience of the humans who lived on the farm.

Table 11. Site inventory and analysis by using landscape ecology and Fengshui principles: Dairy Farm

	Description	Landscape Ecology Ideas	Score	Suggested Changes (LE)	Fengshui Ideas	Score	Suggested Changes (FS)
Wind	The site was located on the Canterbury plain. Only the north and west side of the farm were surrounded by the mountain in the far distance, strong winds can come through the site without a buffer. The site had continuous forest and shrubs on the west side. The farmer planted short shrubs around the house as wind protection.	For the site with a flat landform, wind erosion control can maintain vegetation and control streamline airflow.	**2**	Plant a continuous shelterbelt around the site especially on the south side to block the wind. Plant trees at the side of the house to protect it from wind.	An ideal Fengshui location is a semi-enclosed space for farmland and settlement with mountains surrounding it at the back, left, right and relatively opened at the front. This kind of arrangement forms a defensive arrangement against cold and wind.	**3**	If the site is too flat and lacks large mountains, vegetations like a Fengshui Forest arranged behind and at two sides of the dwelling could remedy the imperfect landscape.
Water	A river flowed by the east side of the farm. The farm had two water channels through the site from north to south. Both channels and rivers were curved and narrow. The water in the water channel was clean and quiet with small speed.	A vegetated stream corridor is essential to maintain aquatic condition. Maintain "ladder-pattern" of large open patches crossing the floodplain The corridor should be wide enough to control flooding.	**3**	Plant more vegetation around the bank of water channel. Plant more trees and shrubs at the river branch to purify the water before it flows into the river. Widen the width of the stream.	A winding inward river flow in front provides the ideal Fengshui location with a resource for drinking, irrigation, agriculture, air purification, microclimate modification and humidity. A river curving inwards should flow between An Shan and Ming Tang.	**3**	The sites where river the enters and exits should be surrounded by a mountain or hill. The exit of the river should be narrow
Vegetation	The vegetation around the stream was single and short, and could not provide shade to decrease the water temperature in summer. The existing plants were located along the road and at the corner of the buildings for decoration. The farmland lacked biodiversity.	Large patches of natural vegetation can interconnect the stream and sustain a viable population of natural habitat. A buffer zone around the stream can reduce the influence of the surrounding on the inner of protected area.	**2**	Design patches of shrubs on the farm to enhance biodiversity. Plant more species along the bank of the water channel.	The Fengshui location requires thriving vegetation to attract animals and support a stable ecosystem.	**2**	Sparse forest and plants should be planted around the water stream or site boundary to adjust the microclimate. Design connectivity of topographical characters.
Structure	The buildings on the site were mainly located at the centre of the farm instead. The residential dwellings were located towards north.	The house is better set back at a minimum distance from the road and a maximum from the corridor.	**4**	The dwelling was close to the road, no suggested solution.	Focal points are groupings of features to catch people's attention and make it easy to monitor the natural environment. The ideal site is located at the convex bank side of the river to prevent gradual erosion and potential hazards.	**1**	Relocate the building at the convex bank side of the river to prevent gradual erosion and potential hazards. Buffer the house with bush to protect it from "Sha Qi".
Road	The existing roads on the farm were curved and oriented horizontally. The road was close to the water channel. The turning corner was designed based on the location of buildings.	The human edges tend to be straight and simple. The road tends to be completely connected and relatively straight.	**4**	No suggested solution.	Design a curved road on the farm with orientation horizontally	**2**	The road should be designed in front of the buildings. The houses inside the bends of a road can benefit from the gentle collection of Qi.
		Total Score	**15**			**11**	

4.2.2 Organic Farm

The existing layout of the site indicated that the "Qi" on the site was unbalanced. As the farm was relatively flat, the way to circulate the "Qi" of the site was by the spatial arrangement of plants, quantity of water, and flow of wind. At the north part of the farm, wind, and water carried the "Qi" flow from northwest to the southeast. The energy was trapped in the reserved forest patch. As the two patches of the farm were divided by a road, its natural habitat was relatively isolated, "Qi" could not pass to the south part of the farm. In the south patch, "Qi" could not stay and easily flowed away together with the wind and the river. Based on this unbalanced and unstable environment, the farm had seasonal flooding which meant the presentation of unbalanced "Qi". The existing layout of the roads had adverse effects on the Fengshui of the farm. In the north part of the farm, the road was designed along the waterway and went through the existing forest. When driven through the forest, a hard machine would bring "Sha Qi" into the forest. In other words, the natural habitat and ecosystem were disturbed by the road. A further detailed analysis of the farm is shown in Figure 32.

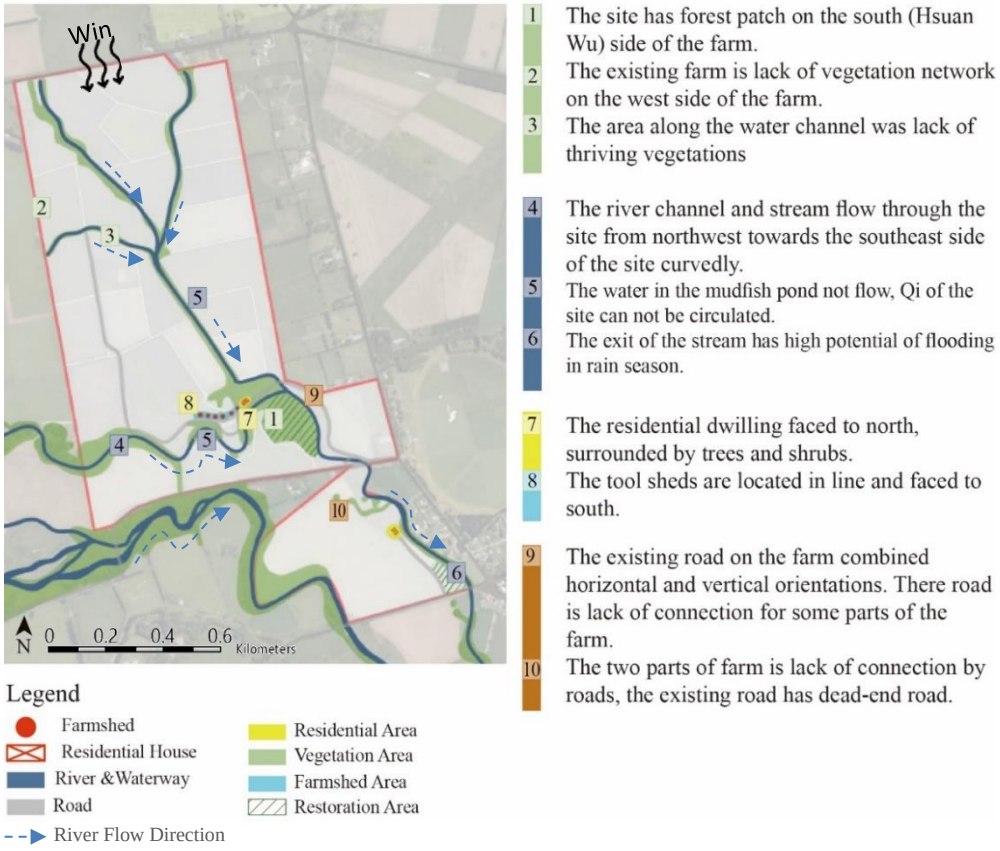


Figure 32. Organic farm analysis

The site inventory and analysis of the farm layout based on Fengshui and landscape ecology were shown in Table 12. The score showed that the analysis of most landscape features like wind, water, vegetation, and structure had a similar score when compared with the two principles. The variation arose from the analysis of the road structures of the farm by using these two principles. Landscape ecology focused on protecting the integration of the natural habitat which minimized the disturbance to the surrounding environment, while Fengshui emphasised taking the road as another form of water that carried "Qi" and flowed through the site smoothly.

Table 12. Site inventory and analysis by using landscape ecology and Fengshui principles: Organic Farm

	Description	Landscape Ecology Ideas	Score	Suggested Changes (LE)	Fengshui Ideas	Score	Suggested Changes (FS)
Wind	The organic farm was located on the Canterbury plain. Only the north and west sides of the farm were surrounded by mountains in the far distance. The site had a forest on the south side of the farm to buffer the strong wind.	Wind erosion control can maintain vegetation and control streamline airflow.	**2**	Plant a continuous shelterbelt on the west side of the site. Connect the restoration area on the south side of the farm with existing patches to enhance the connectivity of patches	An ideal Fengshui location is a semi-enclosed space for farmland and settlement with mountains surrounding it on the back, left, right and relatively open at the front. This kind of arrangement forms a defensive arrangement against cold and wind.	**3**	Create a semi-enclosed space by using trees and shrubs to protect from and mitigate strong wind. If the site is too flat and lacks largemountains, vegetations like Fengshui Forest arranged behind and at two sides of the dwelling can remedy the imperfect landscape.
Water	The river channel and stream flowed through the site curvedly. The water in the mudfish pond did not flow with shallow water level. The artificial drainage channel protected the adjacent organic plants from flooding. The exit of the water channel had high potential for flooding in the rainy season.	A vegetated stream corridor is essential to maintain aquatic condition. Maintain "ladder-pattern" of large open patches crossing the floodplain The corridor should be wide enough to control flooding.	**2**	Widen the channel water, use the existing landform to create a natural seasonal pond for mudfish. Select and plant suitable vegetations along the corridor.	A winding inward river flow in front provides the ideal Fengshui location and is a resource for drinking, irrigation, agriculture, air purification, microclimate modification and humidity. A river curving inwards should flow between An Shan and Ming Tang.	**3**	Gather and purify 'Qi' in the restoration area while makeing the water flow in a very slow speed. Widen the channel, use the existing landform to create a natural seasonal pond for mudfish. Create a backup water channel at the exit of the river to divide rain season water.
Vegetation	The site was preparing a native plant field for ecological restoration. The site had a forest patch on the south side of the farm. The existing farm was lacking of vegetation network on the north side of the farm.	Large patches of natural vegetation can interconnect the stream and sustain a viable population of a natural habitat. A buffer zone around the stream can reduce the influence of the surroundings on the inner side of the protected area.	**3**	At macroscale, design native vegetation corridor for systematic water-plant cooperating system. Create continuous vegetation patches along the waterway.	The Fengshui location requires thriving vegetation to attract animals and support a stable ecosystem.	**3**	Sparse forest and plants should be planted around the water stream or site boundary to adjust the microclimate. Design connectivity of topographical characters.
Structure	The buildings on the site are mainly located on the east side of the farm by the stream and surrounded by forest. The house for living is facing North while the farm sheds are facing South.	The house is better set back at a minimum distance from the road and a maximum from the corridor.	**3**	Move the farm shed and residential dwelling away from the restoration area.	Focal points are grouping of features to catch people's attention and make it easy to monitor the natural environment. The ideal site is located at the convex bank side of the river to prevent gradual erosion and potential hazards.	**3**	Move the residential building to the place with water at the front and forest at the back and facing to the North or Northeast. Change the orientation of the toolshed towards North.
Road	The existing road on the farm combined horizontal and vertical orientations. The road lacked connection to some parts of the farm.	Human edges tend to be straight and simple. The road tend to be completely connected and relatively straight.	**3**	Enhance the connectivity of the farm by designing tracks and roads.	A good fengshui site should avoid a road with dead-end. The road should be curved and orientate horizontally.	**1**	The road should be designed in front of the buildings with curved shape. Avoid T shaped road with a building nearby.
		Total Score	**13**			**13**	

4.2.3 Grazing Farm

The layout analysis by using Fengshui principles was shown in Figure 27. The landform of the farm laid a good foundation for the site Fengshui. The farm was located on a peninsula facing to the bay. The semi-enclosed landform curved inward s towards the Ming Tang. The residential dwelling was located at Ming Tang, which is a good location for people to live. Based on Fengshui principles, the more hills surrounding it, the more natural shelter the site has to against the hazards. The hill at the back was Hsuan Wu Mountain. The other two sides were Green Dragon and White Tiger Mountain. The existing Hsuan Wu Mountain was the same size as Qing Long and Bai Hu Mountain, and was not magnificent. “Sha Qi” could easily flow from the back of the valley and reach the living area at the front. The effect of “Sha Qi” flowing from the back was closely related to the soil erosion at the back of the hill slope area.

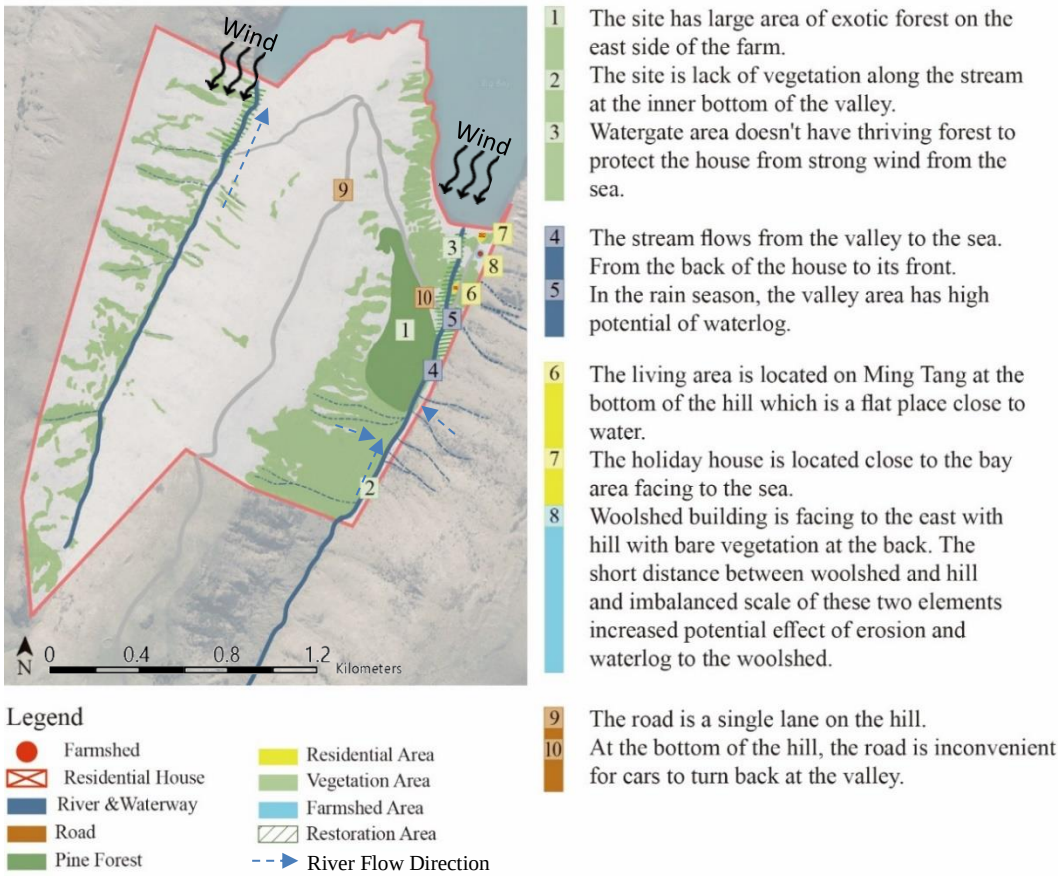


Figure 33. Grazing farm analysis

The site inventory and analysis of the farm layout based on Fengshui and landscape ecology was shown in Table 13. This farm had a relatively good farm layout compared with the other two farms as the total scores were the highest among them. The analysis of site wind and water flow had variation. Landscape ecology focused on the effect of wind and water on the soil erosion problem, while Fengshui emphasised the effect of landform configuration on the wind flow condition, and the effect of the river shape on its surrounding macroclimate. On the other hand, these two principles both mentioned that vegetation can be used to mitigate soil erosion and strong wind control. The building structure was located in a good position according to the analysis of these two principles. The road shape of the site from the Fengshui point of view needed a small change.

Table 13. Site inventory and analysis by using landscape ecology and Fengshui principles: Grazing Farm

	Description	Landscape Ecology Ideas	Score	Suggested Changes (LE)	Fengshui Ideas	Score	Suggested Changes (FS)
Wind	The farm was located on a peninsula facing the bay area. The semi-enclosed landform surrounds the living space and formed an enclosure environment while strong winds could flow into the farm. The wind from the inner valley intensified the erosion on the hill slope.	Wind erosion control can maintain vegetation and control streamline airflow.	**3**	Enhance natural restoration on the area with erosion potential. Plant trees at the bay area to protect the living area from strong wind.	An ideal Fengshui location is a semi-enclosed space for farmland and settlement with mountains surrounding it on the back, left, right and relatively open at the front. This kind of arrangement forms a defensive arrangement against “Sha Qi”.	**2**	Grow plants on the hill slope to mitigate the effect of “Sha Qi”.
Water	The stream flowed from the valley to the sea, from the back of the house to its front. In the rainy season, the valley area had a high potential for waterlog issue. The water flushed from the hill slope intensified the soil erosion condition.	A vegetated stream corridor is essential to maintain aquatic condition. Enhancing the connectivity of the water corridor will contribute to mitigating the drainage problem.	**2**	Connect the water channel from the hill slope to the stream in the valley. Plant native vegetation along the water channel.	A winding inward river flow in front is the ideal Fengshui location which provides a resource for drinking, irrigation, agriculture, air purification, microclimate modification and humidity. A river curving inwards should flow between An Shan and Ming Tang. Qi is gathered at the place with water and an area of plants.	**3**	Widen the stream in front of the dwelling to gather the water and store the wind (藏风得水).
Vegetation	The site had large area of exotic forest on the east side of the farm. On the top of the hill, the major land cover was native flax. The site lacked vegetation along the stream at the inner bottom of the valley.	Large patches of natural vegetation can interconnect the stream and sustain viable population of natural habitat. A buffer zone around the stream can reduce the influence of the surroundings on the inner protected area.	**3**	Create continuous vegetation patches along the waterway.	The Fengshui location requires thriving vegetation to attract animals and support a stable ecosystem. A Fengshui Forest can help in blocking “Sha Qi” and preserving “Sheng Qi”	**3**	Sparse forest and plants should be planted around the stream or site boundary to adjust the flow of “Qi”
Structure	The living area was located on Ming Tang at the bottom of the hill which was a flat place close to water. The other building was located close to the bay area faced the sea.	The house is better set back at a minimum distance from the road and a maximum from the corridor.	**4**	The existing site is located on an excellent focal point with nice orientation.	Focal points are grouping of features to catch people’s attention and make it easy to monitor the natural environment. The ideal site is located at the convex bank side of the river to prevent gradual erosion and potential hazards.	**4**	No suggested solution.

Road	A single curved road on the hill ridge connected living area in the valley. At the bottom of the hill, the road was inconvenient for cars to turn back.	Human edges tend to be straight and simple. Roads tend to be completely connected and relatively straight.	**4**	No suggested solution.	Design a curved road on the farm with orientation horizontally. A good fengshui site should avoid road with dead-end which can block the flow of “Qi”.	**3**	The road should be designed in front of the buildings with a curved shape. Design a “Y” shape road to avoid dead-end.
		Total Score	**16**			**15**	

4.2.4 Summary of the Existing Farm Layout Interpretation

Based on the Fengshui principles, these three farms covered all the essential environmental features: flowing water, human settlement, road, vibrant vegetations, the flow of wind, and sunlight. According to the farm analysis, Fengshui recognized all the environmental issues based on the concept of “Qi”.

The Dairy Farm had a flat open landform and without the blocking by plants, it was hard to gather “Sheng Qi” on the site. Once “Sheng Qi” flowed out of the farm in the wind, “Sha Qi” from the ground would have an adverse effect on the landscape. This imbalanced energy flow caused a waterlogging issue on the ground. The Dairy Farm did not make use of the environmental features to regulate “Qi.” The height of the water bank vegetation, the width of the water channel, and the function of shrubs near the house did not help with “Qi” regulation. Moreover, there was no functional shelterbelt along the edge of the farm to regulate the wind so livestock may be affected by strong wind and hot sun which would affect their productivity.

The Organic Farm had a better environmental foundation to regulate “Qi”, but the uneven distribution of vegetation caused an imbalanced “Qi” flow. The seasonal “Sha Qi” from the north side could not be mitigated by the shrubs and trees along the water channel, which caused seasonal flooding in the rainy season. On the other hand, the natural habitat of the farm did not have thriving vegetation to collect “Sheng Qi” and this was the reason for mudfish habitat loss in the reserved area. About the infrastructures on the site, both of the dwellings on the farm were not in a sunny direction. The lack of sunlight would bring “Sha Qi” into the human living and production areas.

The environmental condition of the Grazing Farm was the best among the three farms. Its hilly “armchair shape” landform was similar to the ideal Fengshui model. The only issue was that the wind from the inner valley was not blocked so “Sha Qi” could easily flow through the valley and cause a soil erosion problem. Moreover, the narrowed water channel in front of the house could not keep the “Sheng Qi” in the residential area.

As the study focused on the harmonious relationship between human activity and its surrounding environments, Fengshui has potential to keep the balance between human and livestock living; agricultural production; and natural restoration. The environmental issues of the Canterbury region including soil erosion, flooding, and biodiversity loss could be shown in the analysis by using Fengshui Principles. Hence, it is worth trying to use Fengshui Principles on the farm layout design to address these environmental issues.

The farm analysis based on landscape ecology and Fengshui principles showed that the interpretation of farm layout had high similarity. Even though the words and terms they used were different, they had principles to identify the same environmental issues. Landscape ecology focused

on the habitat connectivity and systematic relationship between corridor, patch, and matrix; while Fengshui used the flow of “Qi” to analysis the site energy circulation. It emphasised that the balance of “Sheng Qi” and “Sha Qi” was the key to the farm. The environmental issues like flooding, waterlogging, biodiversity loss and soil erosion were all related to “Qi”. Moreover, about the manmade landscape features, landscape ecology principles emphasised that human activity should minimize disturbance of the natural environment, whereas the Fengshui stood for enhancing the living experience of humans on the landscape while respecting nature. The variation in structure and road layout analysis showed the difference in these two principles.

4.3 Farm Changes

Based on the suggested changes of each farm based on landscape ecology and Fengshui principles in Table 11, Table 12, and Table 13, this part redesigned each farm to improve the environmental conditions, especially focused on existing issues and potential natural hazards. The changes included farm layout redesign and detailed redesign.

4.3.1 Farm Layout

The farm layout redesign showed spatial arrangement of function zones and landscape features. For each farm, the layout design was divided into three parts: layout design based on Fengshui principles, layout design based on landscape ecology principles, and the combined design included the strength of the front two designs.

4.3.1.1 Dairy Farm

- Layout design based on Fengshui principles

  The design concept for this farm was to preserve “Sheng Qi” on the site and ensure it frequently flowed through each function zone. The design transferred the waterlogging issue into an opportunity and changed it into the spots to purify “Qi.” It aimed to use water and vegetation to create a natural environment for livestock and humans, hence benefiting from purifying “Qi” in gently flowing water.

  As shown in Figure 34, the design separated the dairy production area and the residential house. The design relocated the residential place to Ming Tang, which ensured the orientation of the house to the north to get enough sunlight. The trees and shrub at the back divided the area from the cows’ activity field while following Fengshui principles which required the house to be surrounded by “Green Dragon”, “White Tiger,” and “Black Turtle.”

  The design enlarged the restoration area along the water channel and connected it with the existing shrubland on the southwest of the farm. Moreover, the design was planned to plant a continuous shelterbelt along the edge of the west and south side of the farm to block the wind and to reduce the wind effect on livestock.

- Layout design based on landscape ecology principles

  The overall goal of the landscape ecology redesign was to achieve environmental restoration and protection for the farm and its surrounding habitat. The proposed plan was divided into three parts, including riparian and wetland revegetation, indigenous boundary planting to provide functional ecological habitat and erosion control around Selwyn River, and existing fence planting to provide stock shelter. The detailed approaches were shown in Figure 35. This

design focused on using the function of native plants to achieve natural restoration. Other elements on the farm such as the road, waterway, and buildings were maintained.

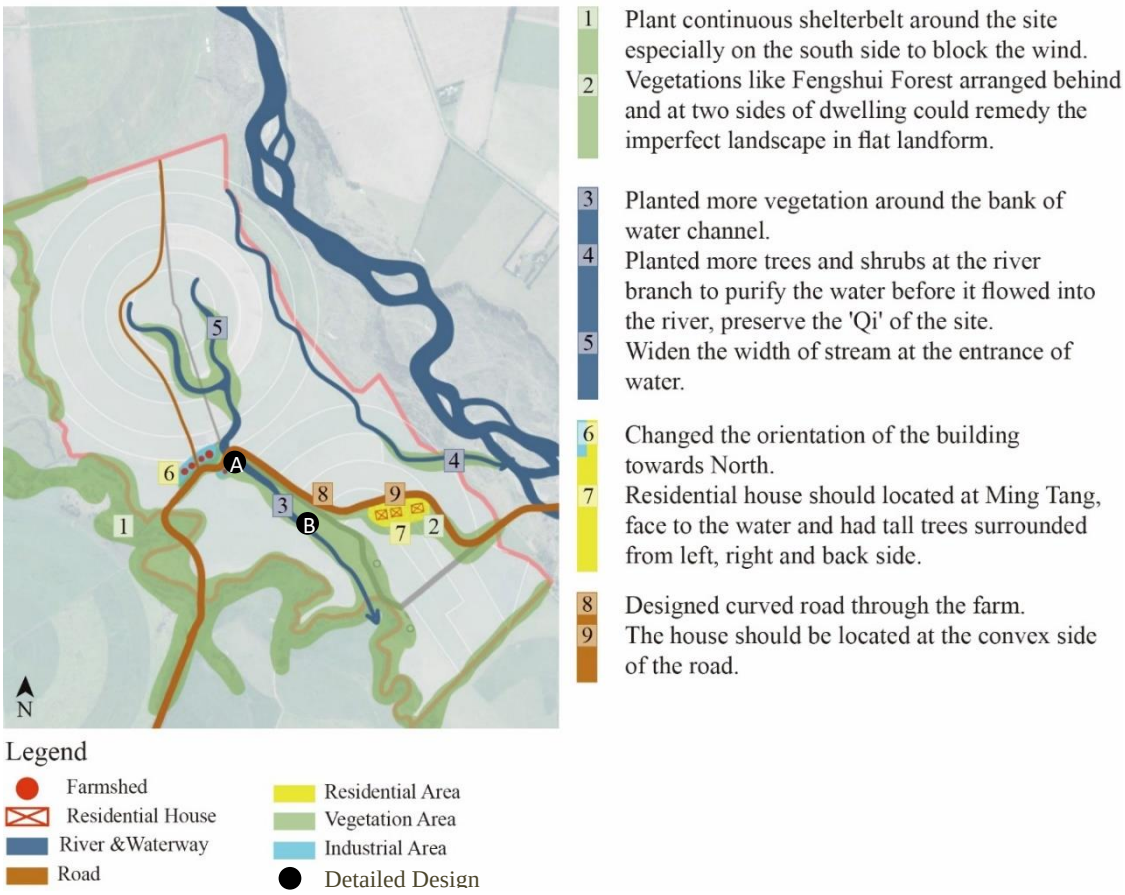


Figure 34. Dairy farm redesign based on Fengshui principles

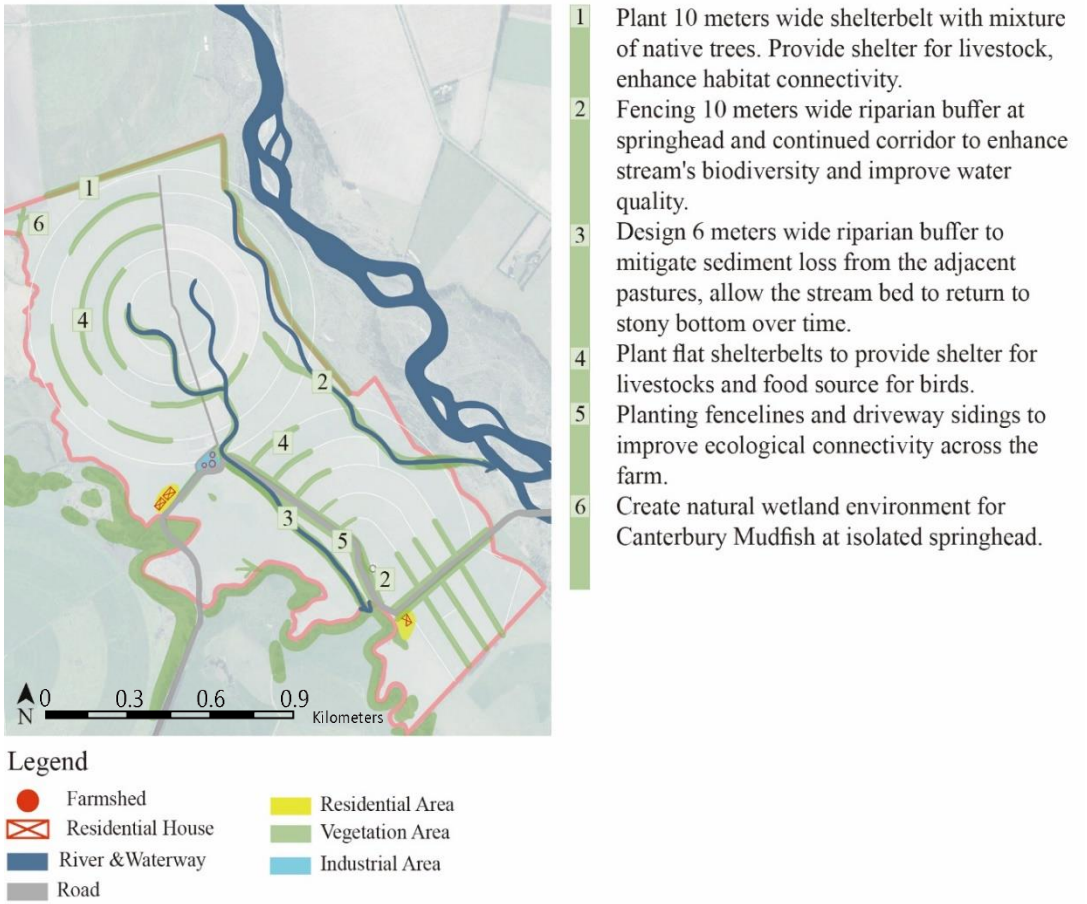
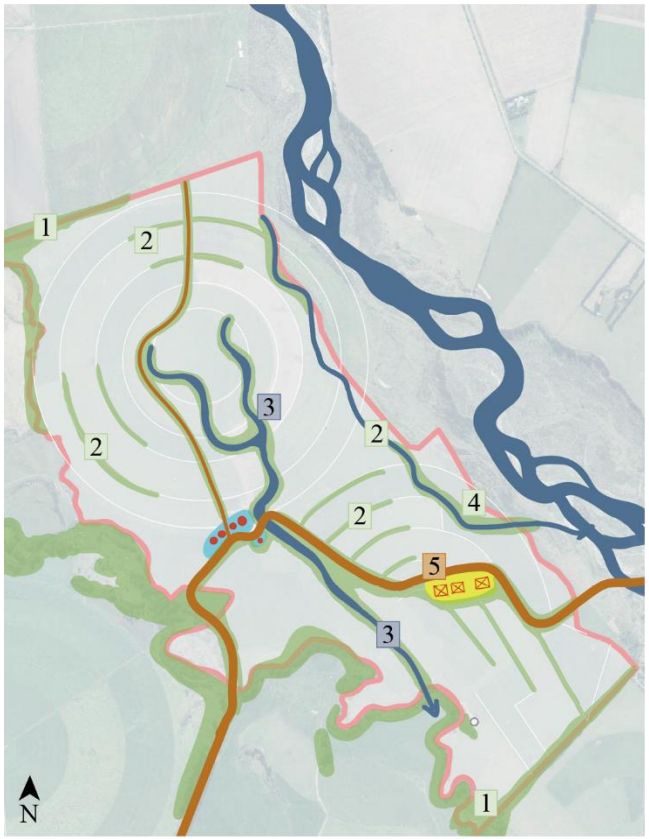


Figure 35. Dairy farm proposed redesign based on landscape ecology principles

- Layout design comparison and final layout design

As shown in Figure 36, the table on the right compared the two design approaches. The design comparison showed that most of the design approaches from landscape ecology could fit with Fengshui principles, which included the design “An Shan” to prevent the leakage of “Qi,” a “Watergate Fengshui Forest” concept, and balance concept at the stream area. The Fengshui redesign and landscape ecology-based design used different approaches to address the same Fengshui principles. Differently to the Fengshui principles that provided a general concept of design, ecology-based redesign was more accurate, trees and shrubs were detailed to certain height and length, which was backed by the ecological concepts. Moreover, the design from landscape ecology considered the need of livestock. It provided a new concept in the design which could not only serve for humans, but also for livestock on the farm. Differently to the Fengshui redesign, the ecology-based design did not consider the environment of the human living area. As a major infrastructure of human activity, roads and buildings played an important role on the farm. These infrastructures also related to the surrounding natural habitat and movement of species. As ecology-based design did not consider road and buildings, the design concept from Fengshui would be maintained in the final design.

As the two redesigns were similar, the final redesign (Figure 36.) maintained the Fengshui redesign's overall layout, integrated the design approaches for livestock into the design, and limited the design to a certain height and width. This result showed that the Fengshui principles could be applied to the farm layout design in the dairy farm case study. Most of the concept was similar to the design approaches based on the ecological concept. Moreover, the Fengshui principles focused on the integrated coordination of the farm, or called the circulation of “Qi”. The elements like road, water, and buildings could also affect the flow “Qi”. The ecological concept helped to fit the Fengshui principles into the farm layout design. The living environment of livestock could also be improved by using the Fengshui principles which were more valuable for New Zealand farms.



Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Residential Area
- Vegetation Area
- Industrial Area

		Fengshui Design	Landscape Ecology Design	Design Comparison	Decision
1	Wind	Plant continuous shelterbelt on the northwest, south, and southeast side of the farm to block the wind. The design can control the wind while preserving the "Qi" in the farm and create a semi-enclosed space on the west, south, and east side of the farm.	Plant continuous shelterbelt on the north and northeast side of the farm to control wind.	Both of the two designs blocked the wind at the farm boundary. Fengshui preserved "Sheng Qi" from flowing out by planting shelterbelt on the south side of the farm which the LE design did not mentioned.	Maintained the shelterbelt concept and combine Fengshui principles with ecology concepts. The design planted 10 meters wide shelterbelt with mixture of native trees on the northwest, south, and southeast side of the farm to enhance the habitat connectivity on west side.
2	Wind	Design "An Shan" to fill the gap to prevent leakage of "Qi" in the farm and reduce the speed of wind when flowing inside from north. "An Shan" should be low shrub or bush compared with "Chao Shan" which is shelterbelt in this design.	Design shelterbelt with 1.5m height for livestocks were located on the flat grassland with arc shape.	In LE design, The shelterbelt filled the gap on west side of the farm and reduced the speed of wind. This design concept fitted neatly with the concept of "An Shan" in Fengshui principle.	Based on the existing location of the shelterbelt at the edge of the farm, 1.5m high "An Shan" shelterbelt was designed with arc shape which followed pivot track and fill the gap of the shelterbelt edge. Provided shelter for livestock, avoid leakage of "Sheng Qi". Use shelterbelt to mitigate the waterlog issue on the farm.
3	Water	Use the contrast of hard and soft, move and stable, to keep the balance at the stream area. Widening the width of stream entrance can allow	Design buffer along the water channel to mitigate the sediment loss. Remain the existing shape and width of water channel.	The LE design relied on the ecological regulation service of riparian buffer to mitigate the sediment loss. The result could return the stream bed to stony buttom, which was another balance between hard and soft in Fengshui principle.	The design combined the two concepts together and designed 6m riparian buffer along the water channel. What's more, it put stones along the edge of bank to mitigate the sediment loss. At the entrance of stream, the design widened the stream to 3m and expand the catchment area, reduce the speed of water in rain season.
4	Vegetation	Based on "Watergate Forest" concept, design clusters of native vegetation at watergate to purify the water before flowing into river, gather the "Sheng Qi" on the site and prevent it leaking out.	Design riparian buffer with 10 meters to protect the biodiversity along the riparian area.	The LE design concept could enhance water quality and benefit to biodiversity in riparian area and fits with Fengshui principle.	The design maintained the concept of the Watergate Forest at riparian area, planted native trees and shrubs as native buffer with 10 meters wide.
5	Structure & Road	Move the building to Ming Tang, facing to the north. Road can be seen as another form of "water" in Fengshui principles. Design curved road and located house inside the bends is benefit from gentle collection of "Qi".	Infrastructure like road and house were not considered in the LE design. In ecological concept, curved road provides greater habitat diversity than straight road.	The existing house was located adjacent to the flat, straight road which didn't have good or bad Fengshui.	The residential house located on the inner curved road and facing to the flowing stream at the front was benefit for people living in. The design maintained the Fengshui design, changed the existing straight road into curved road and relocate the dwelling to inside bends of the road.

Figure 36. Dairy farm design comparison and final design decision

4.3.1.2 Organic Farm

- Layout design based on Fengshui principles

  The design concept for the farm was to arrange the layout of each landscape feature (forest patch, water channel, house, and road) to allow "Qi" to circulate through the whole site. There were three steps – collecting, preserving, and flowing out of the farm. The design concepts were shown in Figure 37. The design aimed to create a stable "Qi" circulation environment in the farm to mitigate the flooding issue and create a comfortable living habitat for mudfish.

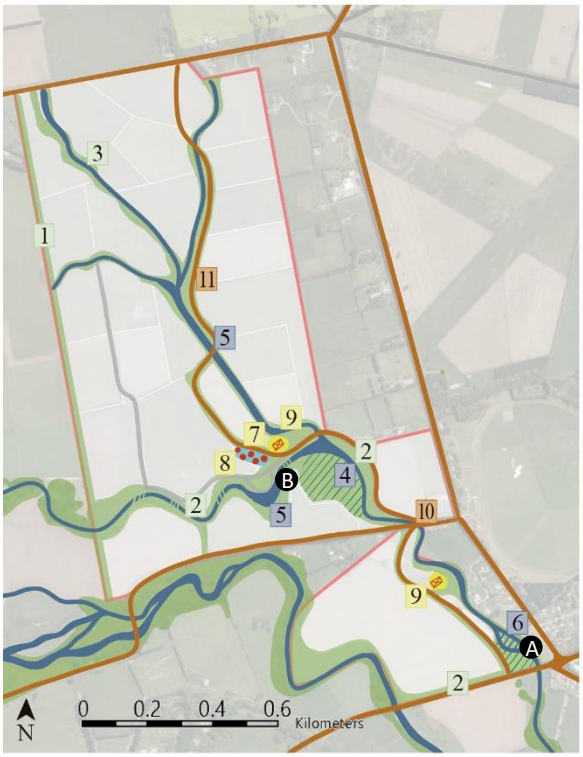
  Firstly, based on wind flow and sunlight, "Qi" came from the northeast of the site. The design planted a shelterbelt along the west edge of the farm to collect "Qi". As the water channel of the site was a branch shape, water flowed from the north side, gathered in the middle of the farm, then flowed as a single channel to the southeast of the farm. The "Qi" could be collected and delivered following the waterway.

  Secondly, preserving the energy of "Qi." This step combined sunlight, wind, water flow, and natural habitat together. Each element could be seen as a "filter" to purify the "Qi" and preserve the good energy. By extending the reservation area and connecting it with surrounding water channels, "Qi" would be gathered in the forest area. Moreover, it could provide a larger living environment for mudfish.

  Thirdly, ensure the "Qi" flowed out from the south part of the farm gently. As the road in the middle divided the farm, the "Qi" would be delivered to the south part of the farm by a water channel, connecting the shrubs and the road. The design aimed to ensure the "Qi" can flow out without intensifying potential natural hazards like flooding. At the Watergate area, design a floodable restoration environment as a retention pond in the rainy season to protect the surrounding farm. The Watergate area should be relatively open to reduce the speed of the water.

- Layout design based on landscape ecology principles

  The design vision was to enhance the ecological health of the farm to showcase the conservation and restoration opportunities in Canterbury. As shown in Figure 38, the proposed design was intended to provide ecosystem services while enhancing the breeding habitat and food resource for mudfish. The location of the design focused on a series of corridors along drains and crop margins above the main river corridor which was the living area of mudfish. To enhance ecological connectivity and ecosystem services, the selected site was planted with ingenious species in an approximately 3-tiered mixture of shrubs, small to medium trees, and some larger native trees where appropriate like Toitoi, Wiwi, and Ti Kouka.



1 Plant continuous shelterbelt on West side of the site.
2 Connect the restoration area on south side of the farm with existing patches to complete 'Hsuan Wu'.
3 At macroscale, design native vegetation corridor or patches for systematic water-plant cooperated system.

4 Enlarge restoration area at watergate to ensure the internal circulation of 'Qi'.
5 Widen the channel, use the existing landform to create a natural seasonal pond for mudfish.
6 Create backup water channel at the exit of the river to divide the water in rain season. Borrow the existing landform to contain the water.

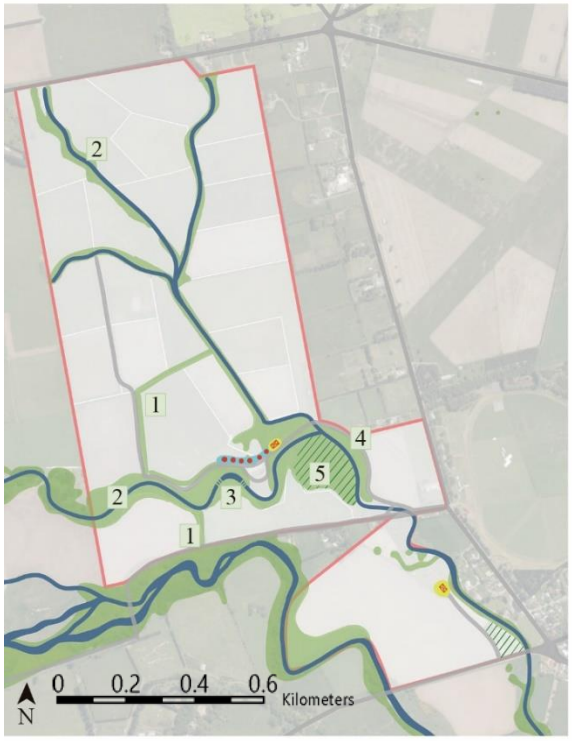
7 Buildings should facing North.
8 Move the farm shed and residential dwelling away from restoration area.
9 Residential zone should be surrounded by trees and shrubs while facing waterbody to close to the purified 'Qi'.

10 Create connected road network with curved shape to connect the two parts of farm.
11 Relocate the road on the farm to flat area.

Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Detailed Design
- Residential Area
- Vegetation Area
- Farmshed Area
- Restoration Area

Figure 37. Organic farm proposed redesign based on Fengshui principles



1 At shrubs and crop margins, select indigenous plant species that support ecosystems adjacent to crops. Provide stabilisation and food for terrestrial fauna.
2 Add species diversity at riparian area and enhance water quality through increasing shading to control the water temperature.
3 Provide suitable living habitat for Canterbury mudfish.
4 Eastablish taller-growing trees species as forest patches. Enhance connectivity between patches.
5 Take advantage of the sheltered space beneath existing forest area and plant native successionary forest species and allow replacement of existing tree stands.

Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Residential Area
- Vegetation Area
- Farmshed Area
- Restoration Area

Figure 38. Organic farm proposed redesign based on landscape ecology principles

- Layout design comparison and final layout design

As shown in Figure 39, the table on the right compared landscape ecology-based design approaches with the relative Fengshui principles in the previous redesign. According to the comparison, most of the design approaches from landscape ecology could fit with Fengshui principles, which included the circulation of “Qi”, “Watergate Forest”, and the balance of natural elements.

In both redesigns, the continuous shelterbelt was designed along the water channel as a natural buffer. Based on the Fengshui principles and ecological concept, this approach could not only provide a semi-enclosed space on the west and south side of the farm to block the wind, but also connect the natural habitat with native plants. The final shelterbelt redesign promoted the fusion of the two concepts. It maintained the layout of the shelterbelt in Fengshui redesign to preserve “Qi” in the farm. About plant spatial arrangement, it borrowed the concept from landscape ecology proposed redesign, created a gradually raised buffer along the water channel from grass, shrub, to the tall-growing forest. In winter, this layout could block the cold wind from south while open to the sun in north. In summer, the gradually raised buffer could provide shadow which reduced the water temperature.

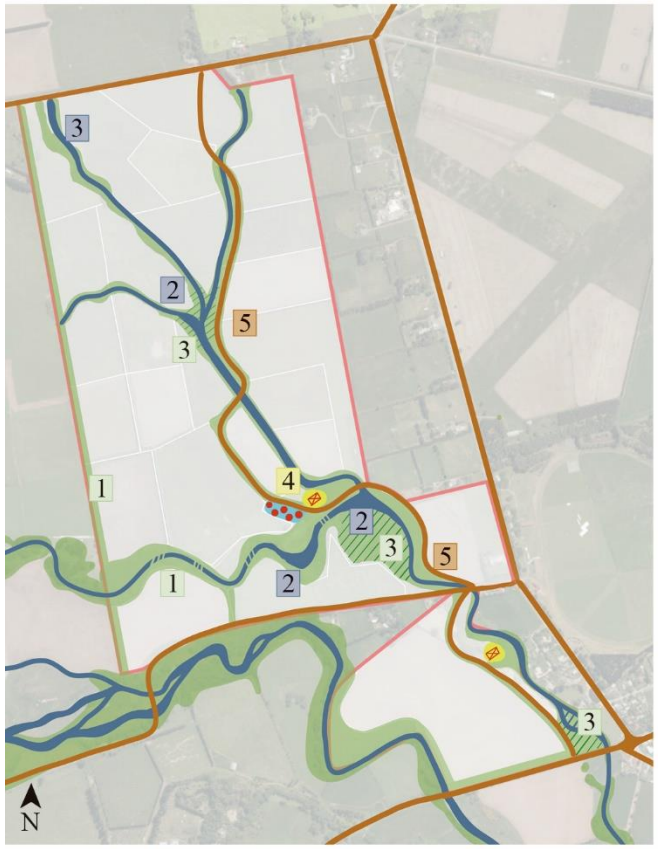
In Fengshui principles, the concept of “Watergate Forest” required two criteria – the native bush or forest, and that the patch should be located close to the watergate. In the Fengshui redesign, the existing natural forest patch was extended and covered the water conjunction area in the north part of the farm. In the south part of the farm it was proposed to plant flood-tolerant shrubs and trees to mitigate the flooding issue of the site. The landscape ecology design concept was similar to the Fengshui principle and suggested planting native trees next to the existing area along the watergate in the north part of the farm, which could purify the water quality and reduce the water temperature. Different to the Fengshui redesign, landscape ecology-based proposal ignored the flooding potential on the south part of the farm. As the design approaches around the watergate area in the north farm were the same, the final redesign combined the Fengshui redesign with the landscape ecology-based redesign, extended the existing restoration forest, and planted tall-growing trees around the water. In the south farm watergate area, the final redesign maintained the Fengshui redesign approach to mitigate the rain season's flooding issue.

The mudfish habitat in the water channel was considered in both redesigns. Fengshui redesign focused on widening the channel and borrowing the fan-shaped water branches on the farm to gather and slow down the speed of “Qi”. The stabled water environment could provide a comfortable living habitat for mudfish. In Dan’s proposed design, adding species along the water channel could affect the water quality and provide suitable living habitat for Mudfish. Based on the Fengshui principle, his approach could also contribute to “Qi” gathering. As widening the

water channel and adding native plants along the bank could be achieved simultaneously, which was contributed to both the circulation of Fengshui, and the mudfish habitat, the final redesign decided to take both of these approaches and apply them on the water channel area together.

A well-designed road and building following the Fengshui principles could contribute to the surrounding natural habitat, have a positive effect to the “Qi” circulation of the site, and benefit to human living quality. Based on the landscape ecology-based proposal, the infrastructure design was totally maintained, and other ecological approaches which were proposed bypassed it. In Fengshui's idea, any design on the site had a consecutive effect on the surrounding environment. Based on the site analysis, the road and building along the water channel disturbed the integrity of the natural habitat and species movement. Moreover, the orientation of the building meant it could not get enough sunlight to support human activity. To achieve natural restoration and provide a comfortable living habitat for mudfish, it was necessary to use Fengshui principles to relocate the road and buildings on the farm. The final redesign maintained the design concept from the Fengshui redesign about buildings and road. It borrowed the detailed design concept of a native buffer around the water channel and tried to preserve the integrity of the natural environment for insects, mudfish, and native plants.

Overall, compared with the two redesigns, most of the landscape ecology-based redesign fit with Fengshui principles very well. The landscape ecology redesign made use of the native plants’ ecological functions to regulate the natural environment. Its very detailed design provided a suitable solution based on the site condition. Fengshui principle, as a concept focused on the flow of “Qi” and the integrity of the site and brought all the elements on the site together to enhance the environment. The cooperation of these two redesigns provided an eclectic solution to apply Fengshui principles into the farm with unique local characteristics.



Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Residential Area
- Vegetation Area
- Industrial Area
- Restoration Area

		Fengshui Design	Landscdape Ecology Design	Design Comparison	Decision
1	Wind	Plant continuous shelterbelt on the west and south side of the farm to block the wind. The design controlled the wind while preserving the "Qi" in the farm. Created a semi-enclosed space with "Qing Long" and "Hsuan Wu".	At shrubs and crop margins, select indigenous plant species that support ecosystems adjacent to crop margin.	The LE design along the water channel was a well connected and multi-functional natural habitat with native shrub, tall-growing forest, and grass.The linear spatial arrangement created a natural buffer, to control wind speed which was the same concept as "Hsuan Wu" in the Fengshui principle.	Preserving "Qi" and allow it flow through the site was one of the key aspect of Fengshui principle. The redesign maintained the design concept from the Fengshui redesign. It selected the same species as the area of the taller-growing tree in the landscape ecology design and enhanced connectivity between water channel buffer and the shelterbelt in the west.
2	Water	The existing water channel with multi branches can gather "Qi" very well. Widen the channel can slow down the speed of "Qi" and allow it gather and purify to create a health natural environment for flora and fauna.	In the Mudfish habitat area, adding species diversity positively affected the water quality and provided suitable living habitat for Mudfish.	Adding native plants was another way to slow down and gather "Qi" in the riparian area. Widening channel and enhancing species diversity could be applied together.	Combined the Fengshui principle with ecological concept. Widen the water channels especially in the intersection area and mudfish ponding area to slow down water speed, deposit sediment, and buffering "Qi", hence, mitigate the flooding issue in rain season. Added species diversity along water channel to and create a well connected suitable living habitat for Mudfish.
3	Vegetation	Based on "Watergate Forest" concept, design clusters of native vegetation at watergate to purify the water before flowing into river, gather the "Sheng Qi" on the site and prevent it leaking out.	Add species diversity at riparian area and enhance water quality through increasing shading to control the water temperature.	The taller-growing trees species proposed next to the existing area along the Watergate in the north part of the farm were the same as the "Watergate Forest" concept in Fengshui principle.	The design maintained the design of the backup water channel concept and enhanced natural resto-ration around the watergate in the south part of the farm. For the north part of the farm, borrowed the concept of tall-growing trees and enhanced connectivity with the existing restoration area.
4	Structure	The natural forest and plants should support "Ming Tang" from its left, right, and back. The living area should facing to the flowing water which is suitable for people living in.	The landscape ecology design didn't consider moving the existing location of the dwelling and human activity area to keep the natural environment's integrity.	The 10m corridor around the water channel was broken by the farm shed area and disconnected the natural patches.	The final redesign moved the existing buildings away from the restoration area. Separated the industrial and living area by road and minimized human activities' intervention to the natural environment. The residential house located on the inner curved road and faced toward the flowing stream at the front was benefit for people living in.
5	Road	Design curved road and located house inside the bends is benefit from gentle collection of "Qi".	Road not considered in landscape ecology design.	Curved road provides greater habitat diversity than straight road. The road avoids integrated natural habitat can minimize the intervention of human activity.	The design maintained the Fengshui redesign, changed the existing straight road into curved road, moving the road away from a integrated native patch, and connect two farms by road.

Figure 39. Organic farm design comparison and final design decision

4.3.1.3 Grazing Farm

- Layout design based on Fengshui principles

Based on the analysis, the key design concept was to protect the farm from “Sha Qi.” In other words, to mitigate the effect of strong wind on the landscape. Three elements could bring “Sha Qi” to the site – stream, wind, and the road. The farm redesign would mainly focus on these elements. Figure 40 shows the farm redesign layout.

To block the strong wind from the bay area, trees and shrubs should be planted around the watergate. Moreover, the design would increase the density of indigenous shrubs and trees along the stream in the valley and foothill area. “Sha Qi” could be mitigated once layers of forest and shrubs decreased the wind speed. On the other hand, in Fengshui principles, thriving vegetation was a benefit to the natural habitat and could control soil erosion in the hill area.

In the residential area, the stream flowed from the left side of the house to its front curvedly. The design widened the stream and created a small pond to contain the water. In the rain season, it would be a slow flowing stream, while in the dry season, the water could be preserved as a pond. This design changed the waterlogging issue into an opportunity. By planting native vegetations around the pond, “Sheng Qi” can be preserved on the site. The water system with high connectivity could allow “Sha Qi” to flow out of the farm gradually while preserving “Sheng Qi” in the site. In other words, the flowing water could adjust the microclimate of the site to keep moisture and mitigate the waterlogging issue.

Human activity was affected by the transport condition of the site. As the only road on this farm stopped at the back of the dwelling, it stopped the energy. In Fengshui, a road could be treated as water and a good design allows energy to be refreshed and lifted so that the home could enjoy growing “Qi.” As a private road, it was not busy. The redesign extended the road to the front of the house and designed a “Y” shape turning corner (Figure 42). Cars could be able to turn back with minimal intervention on the surrounding environment.

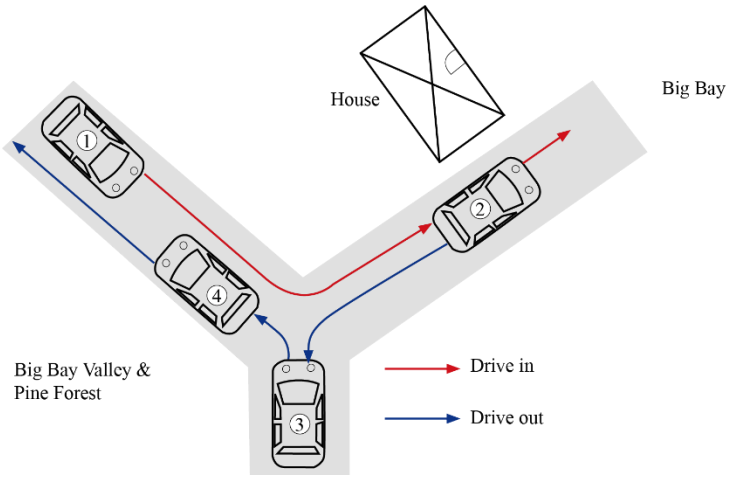


Figure 41. “Y” shape road

- Layout design based on landscape ecology principles

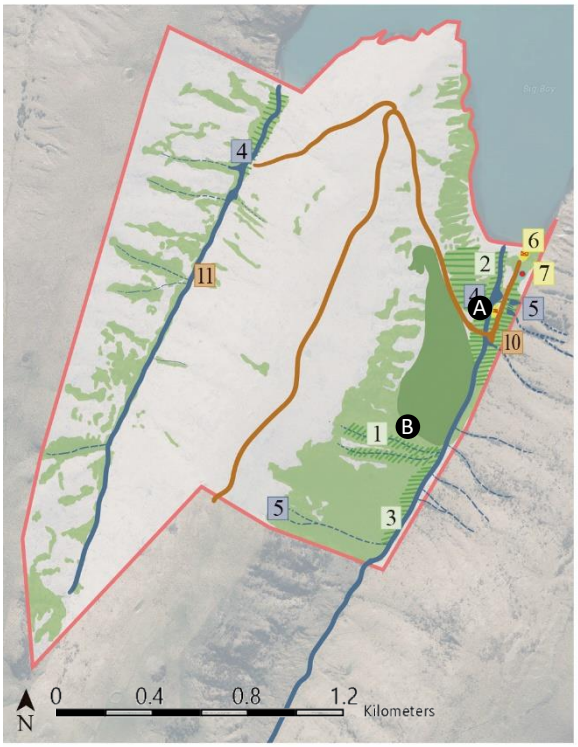
  The proposed redesign considered the site's ecological context, landscape character, and project feasibility and aimed to provide guidance in environmental management and assistance in developing a strategy for the protection and enhancement of its unique indigenous biodiversity. Four design goals guided natural regeneration: fostered natural dispersal vectors to distribute seeds naturally; enhanced the natural character of the landscape and augmented the natural pattern of regeneration; improved ecological connectivity; established functional patch sizes; and enhanced resilience by creating multiple functional habitats (e.g. some area is lost to natural events like fire, landslide, and flood). The proposed redesign focused on using native plants as a tool to regenerate and restore the natural environment while mitigating the existing environmental issue. The detailed strategies are shown in Figure 42.

- Layout design comparison and final layout design

  As shown in Figure 43, the table on the right compared landscape ecology-based design strategies with the relative Fengshui principles applied in the Fengshui redesign. According to the comparison, most of the design approaches from landscape ecology could fit with Fengshui principles. There were six related Fengshui principles. The strategies from Dan only considered three of them, which all belonged to vegetation strategies in Fengshui.

  In the landscape ecology-based redesign, protecting remnant forest by mitigating the edge effect was a strategy that the Fengshui principle did not cover while contributing to native forest protection. This result showed the variation between Fengshui and ecological approaches. The final redesign accepted this approach as it was not in conflict with other Fengshui concepts.

  The final redesign maintained most of the Fengshui redesign concept and borrowed some of the design approaches from the landscape ecology-based redesign (e.g. project timeline, remnant forest protection, and coastal habitat community), it used different elements of the site to regulate the Fengshui of the whole farm. The overall outcome of the final redesign was similar to the Fengshui redesign.



1 Enhance natural restoration on the area with erosion potential.
2 Use Watergate Fengshui Forest to enhance the landscape around the dwelling.
3 Create continuous vegetation corridors along the waterway.

4 Widen the width of stream in front of the house to create natural pond.
5 Create retention space for water when flowing from the hill to the bottom, protect the road nearby from being affected in rain season.

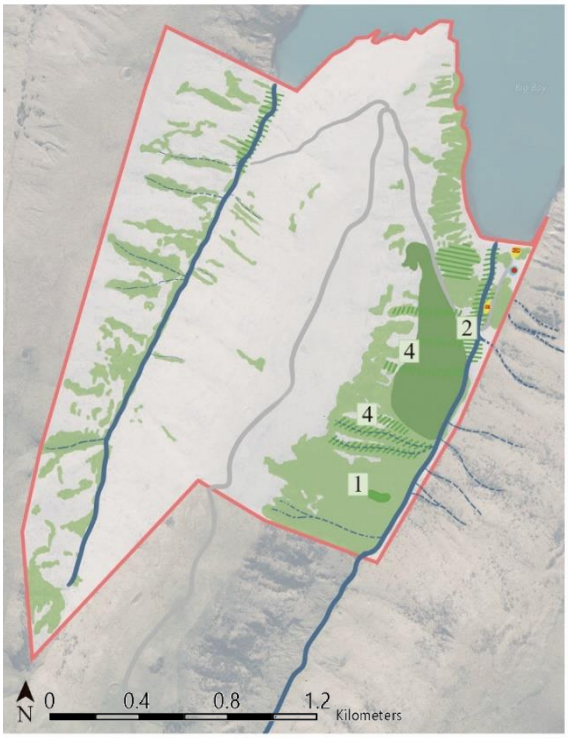
6 The existing residential dwelling and holiday house are located on a good focal point with nice orientation.
7 Change the orientation of woolshed facing to the sea, plant trees at the foothill and design an semi-enclosed space for dwelling with open view to the sea.

8 Redesign and widen the road near the house, enhance accessibility.
9 Design "Z" road shape for cars to turn back.

Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Pine Forest
- Residential Area
- Vegetation Area
- Farmshed Area
- Restoration Area
- Detailed Design

Figure 40. Grazing Farm redesign based on Fengshui principles

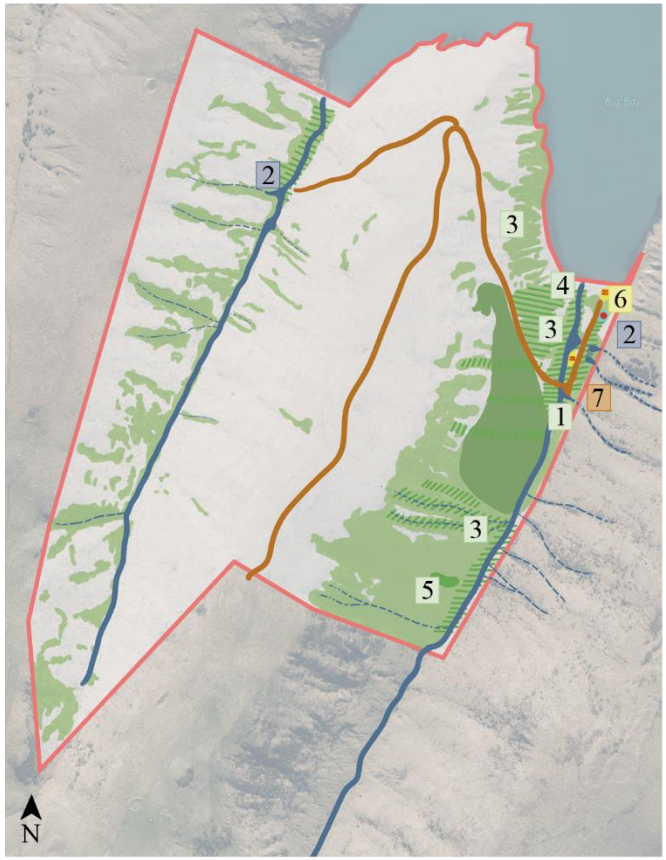


1 Enhance existing forest remnant by mitigating edge effects and restoring the core habitat through a range of management and restoration techniques including buffer planting, redator trapping and graze removing.
2 Assist ecologicapl connectivity by establishing a corridor along the Big Bay stream to connect with the forest patch. This approach could be undertaken over a set time period through the establishment of nodes in close proximity.
3 Plant out foreshore area with coastal species that reflect indigenous coastal plant communities of the region.
4 Re-vegetate steep gullies that run down south-easto slope of main spur. The regeneration should consistent with natural pattern of the existing habitat. The revegetation should begin closest to remnant forest patch and work towards the sea.

Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Pine Forest
- Residential Area
- Vegetation Area
- Farmshed Area
- Restoration Area

Figure 42. Grazing farm redesign based on landscape ecology principles



Legend

- Farmshed
- Residential House
- River &Waterway
- Road
- Pine Forest
- Residential Area
- Vegetation Area
- Industrial Area
- Restoration Area

Figure 43. Grazing farm design comparison and final design decision

		Fengshui Design	Landscape ecology Design	Design Comparison	Decision
1	Wind	The "Back Mountain Fengshui Forest" can help to block the strong wind in the valley and block the flashing soil from the mountain to protect Ming Tang.	Use the vegetation corridor along the steam to fill in the gap between living area and the forest at the back.	The whole process of landscape ecology design suggested being taken over time. This design approach could enhance eco-logical connectivity, which fits with the Fengshui principle.	Different to a Fengshui redesign, the final redesign borrowed the approach from LE, divided the whole process into several stages in 3 years, aimed to achieve the revegetation gradually over time.
2	Water	Design retention pond at the foothill, slow down the speed of "Qi" and make it flow through the site smoothly, hence mitigate the soil erosion in rain season.	LE design did not consider the water channel and its effect to the surrounding environment.	In the Fengshui redesign, retention pond could reduce the impact of water flush to the downhill vegeta-tion, road, and dwelling in the rain season.	The final design maintained the Fengshui redesign approach, designed retention and widened the valley's stream to slow down and gather the "Qi" to protect the farm from severe flush in rain season.
3	Vegetation	Plant "Footstone Fengshui Forest" at the slope's lowland to protect the hill from soil erosion and protect the dwelling in the Ming Tang. The trees in the Footstone Forest should not be too high, and it can not block the view.	Enhance native revegetation by planting native shrubs on the hill slope and the foothill area to mitigate the soil erosion issue	The landscape ecology design fits with the "Footstone Fengshui Forest" principle. It extended the revegetation area to the pine forest patch and headland slope.	The final design maintained the natural restoration approach in Fengshui redesign. It extended the revegetation area from the inner valley slope to the pine forest and headland slope with native shrub. Moreover, the slope near the residential area on the east Big Bay valley should also be revegetated by native shrub.
4	Vegetation	Based on the "Watergate Fengshui Forest" concept, design clusters of native vegetation at watergate to purify the water before flowing into the ocean, gather the "Sheng Qi" on the site, and prevent it from leaking out.	Plant coastal species at the foreshore area near the watergate in front of the dwelling.	The landscape ecology design approach was similar to the "Watergate Fengshui Forest" concept and fit with the Fengshui redesign.	The two redesigns used the same approach. The final redesign decided to maintain the approach of the Fengshui redesign in the coastal area. It borrowed Dan's redesign concept, selected coastal species that reflected indigenous coastal plant communities of the region.
5	Vegetation	Maintain the existing forest patch.	Protect the existing forest remnant by mitigating the edge effect.	The concept of protecting existing forest was not considered in the Fengshui redesign.	The LE approach benefited the native forest remnant protection and core habitat restoration. The final redesign used the LE approach for forest protection. This decision was not in conflict with the Fengshui principles for this farm redesign.
6	Structure	Make the woolshed face to the flowing water .	The landscape ecology design did not consider changing the orientation or location of the dwelling.	The Fengshui redesign on woolshed was only designed to perfect the Fengshui for the site, the change was not essential.	Maintain the current build-ing location and orientation. The less change it is, the less disturbance to the surrounding environment.
7	Road	Design "Y" shape road at the living area to enhance circulation of "Qi"	The design of road was not considered in the LE design.	In the ecological concept, a road that avoids integrated natural habitat can minimize the inter-vention of human activity.	The final design maintained the concept of "Y" shaped road. For a private living area, this design could meet the need for turning while maintaining the integration of the surrounding natural habitat maximized. Moreover, fluent driving in the farm was benefit to the "Qi" flow in the farm.

4.3.1.4 Summary of Farm Layout Changes

- Fengshui design

  The redesign proposal of each farm was purposely designed and addressed its unique environmental issues like soil erosion, flooding, waterlogging, and indigenous biodiversity loss based on the farm's characteristic. Fengshui focuses on the integration of the whole agricultural system. The overall goal of the redesign was to capture the “Qi” in the site and allow it to flow out smoothly. Vegetations like shrubs and shelterbelt forest were used to block the strong wind, enhance water quality, control soil erosion, buffer each function zone, and adjust the macroclimate. Water elements were used to allow “Qi” to flow smoothly through the site and enhance water circulation. With the help of plants along the waterway, “Sheng Qi” could be preserved which was a benefit to mitigate waterlogging and flooding issues.

  Instead of mitigating environmental issues on the farm, the design aimed to improve the living environment and reduce the disturbance of human activity on the surrounding environment. The redesign provided a safe, comfortable, quiet living environment and an isolated industrial environment. Each zone was isolated while well connected. Dwellings were isolated from the native restoration area to reduce human activity disturbance of the natural environment while connected with the natural environment by indigenous vegetation around the house. Moreover, having the house facing north would provide enough sunshine. The road could be seen as another form of water. A curved road would enhance the “Qi” flow and species movement.

- Landscape ecology design

  All these three farms’ redesign was aimed to achieve natural restoration by using landscape ecology principles. The design made use of the function of native vegetation to create a multi-functional ecosystem which addressed the environmental issue like soil erosion, flooding, waterlogging, and indigenous biodiversity loss. Each strategy was detailed to certain height and width.

  In the landscape ecology design, the priority was to create a healthy ecosystem based on the characteristics of the farm and its surrounding environment. Moreover, the living environment of animals was also considered as a major part of the design.

  Compared with the three designs, they only focused on using the function of plants and vegetation to achieve their goals. Other environmental features like river, road, and building were not included in the design.

- Comparison of Fengshui and landscape ecology design

Compared with the two redesign approaches of each farm, most of the redesign strategy could fit with Fengshui principles. This result showed the high similarity of the Fengshui principle with the landscape ecology design strategy. On the other hand, even though the methods were similar, they used different solutions to address it. Different approaches would result in different effects on the surrounding environment, which needed to be discussed separately.

The landscape ecology redesign only focused on using the plants to address each strategy, while the Fengshui theory focused on integrating each landscape element on the site. Moreover, for the Organic Farm and the Extensive Sheep farm, the area of change was limited to a patch or corridor of the farm. The partial redesign could only address the environmental issue of a limited area while the Fengshui design focused on the whole farm and its surrounding environment.

The large-scale design maintained the overall goal of the farm based on Fengshui principles. It used different landscape features to adjust the flow of “Qi” on the farm. The cooperation of each landscape features should be worked as a system as each of them needed to support and connect with each other.

The landscape ecology design was a service for the agricultural landscape and the livestock living on the farm. It was good at arranging detailed elements on the site. The Fengshui principles were focused on the farming landscape and the living environment of humans. Its broad scale concept was a benefit for the whole ecosystem and the macroclimate movement of the farm. As the two studies both focused on the landscape environment, the combination of these two concepts could take both the needs of livestock and human activity into account. The final redesign was a good example of “combination while transformation”. It showed that it was possible that Fengshui principles could be applied into New Zealand’s Canterbury region landscape while addressing the issues that landscape ecology design could not achieve. Meanwhile, the result suggested that Fengshui's application into New Zealand needed to respect the local culture and agricultural characteristics of each farm.

4.3.2 Farm Detail Redesign

The detail design showed the design approaches at the zone level. Firstly, the space design showed the spatial arrangement of the landscape features at detailed level. Secondly, analysed the plant selection strategy for different environmental conditions.

4.3.2.1 Dairy Farm

- Farm spaces design: dairy production area

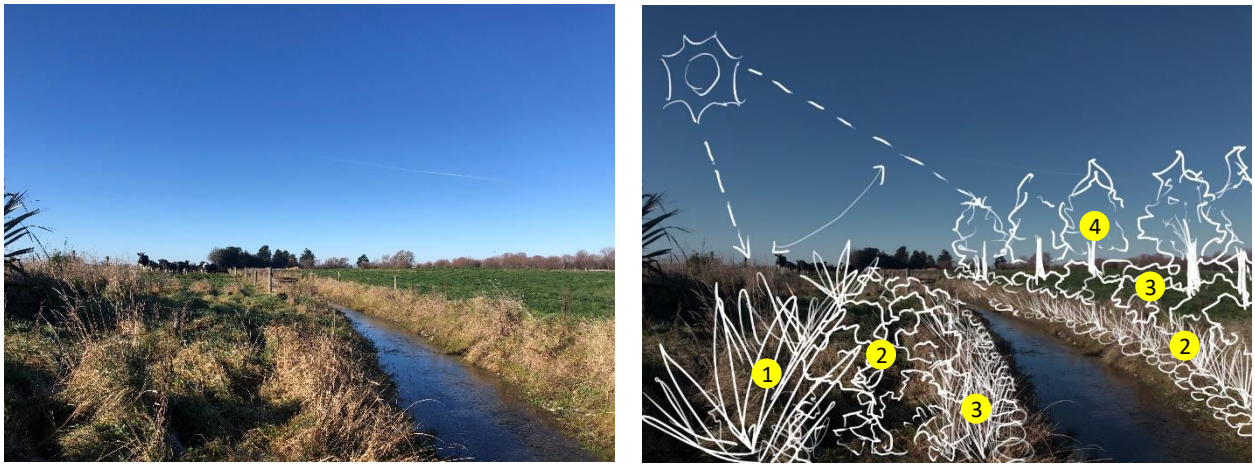
  Figure 44. showed the redesign of the industrial area by using Lumion and Sketch Up. The redesign kept the location of the industrial area while separating the reception office from the farm sheds. In Figure 44, the office faced the north side of the open farm to get enough sunlight. The water flowed through the right side of the building to bring purified “Qi”. On the west, south, and east sides of the office, selected hedges with 2-3m tall surround the building like Miscanthus x giganteus. The design aimed to separate the office from the livestock activity area while maintaining the integrity of the building group with a farm shed. For the farm shed structure, it related to the open grass, which was convenient for milk production without disturbing the water area's natural environment.

Ⓐ Figure44. Dairy production area redesign

- Water channel area planting strategy

  As the existing landform was very flat, it needed vegetation to mitigate it to allow wind flow through the water area and preserve “Qi.” The vegetation along the water channel lacked height while the water channel was too narrow to form a systemic ecosystem. Figure 45 shows the hand drawn redesign of the water channel area. The design widened the water channel to 5 metres and slowed down the speed of water in the rainy season. For each side of the water channel, vegetation was planted with different layers to adjust the microclimate. In Fengshui principles, the balance was the key to the design, including sunlight and shadow; dynamic and static; softness and hardness. This redesign achieved the equilibrium of Fengshui naturally. At the edge of the water channel, the design selected hard stones to contrast with flowing water. For the vegetation selection, the design used the flax with a soft leaf to contrast with the hard leaf shrub and chose low ground cover to contrast with tall trees. The variation of plant selection could

help regulate the circulation of wind and provide shade to adjust the water temperature. The suggested plant species was referred from the farm design by Dan Cameron in Table 14.



Ⓑ Figure 45. Water channel now (left), and proposed design (right)

Table 14. Plant strategy of dairy farm water bank revegetation area

	Species	Common Name	Description	Habitat
1	Phormium tenax	Harakeke	Indigenous flax with a broad green leaf. 2-1.5m tall. Has reddish or yellowish colour flower in spring.	Lowland and coastal areas, wetland, and in open ground along riversides.
2	Coprosma porpinqua	Mikimiki	Bushy shrub with wide-angled branches bearing in clusters. 2m tall. Suitable for a revegetation project.	Prefers moisture soil near streams
3	Carex secta	Purei	Tussock forming sedge around 0.8m tall. Soft drooping thin leaves.	Widespread in the wetland area, prefer moisture soil environment.
4	Cordyline australis	Ti Kouka	The most distinctive plant on farms at 12-20 metres high. Broad straight leaf.	Common in farmland open places

4.3.2.2 Organic Farm

- Farm spaces design: natural restoration area flood control

The restoration site on the south of the farm is under the site preparation stage now. In the existing plan, planting indigenous species could help to restore the native habitat. The contribution to mitigating flooding potential was limited. As shown in Figure 34, the redesign used the “Watergate Fengshui Forest” concept in Fengshui. This design planted native plants to achieve natural restoration while changing the landform of the site to create a retention landform for flooding. In the rainy season, the high-water level and high speed could submerge the surrounding agricultural land. The redesigned site prepared a back-up branch for water to flow in. This concept reduced the water speed, provided a buffer for overflowing water, and trapped the water in the controllable area. As shown in Figure 46, with the water level increased, the water flowed in the branch, the plants and wide surface decreased the speed of the water which minimized the potential effect on the farm adjacent to the road.

Ⓐ Figure 46. Change in water level: low(left), intermediate (middle), and high (right)

- Mudfish living area planting strategy

Figure 47 shows the hand drawn redesign of the mudfish habitat. The design concept was to enhance “Sheng Qi” in the reserved area. The strategy was to enhance biodiversity in the reserved area and enlarge the mudfish’s living habitat. The design widened the width of the pond to increase the area of the mudfish’s living habitat. To preserve “Sheng Qi”, a balanced landscape could stabilise the energy flow. At the edge of the pond, moist tolerant plants are planted to re-inforce the edge of the pond from erosion. As the water channel had seasonal water while the pond is moist all year round, the design used the rock to trap the water in the pond. Meanwhile, Canterbury mudfish could only cope with short period of time without water, so, keeping the pond moisture was another goal of the design. The pond was deepened to preserve more water for mudfish in the dry season. The existing water bank area had little shrub and tussock. Only the trees were connected with the downstream forest patch. To enhance the mudfish’s living habitat, plants could be selected that preferred living in a moist area and suggested species are listed in Table 15. Restoring the natural environment can help to filter “Qi,” enhance the connectivity of the restoration network, and create a better environment for mudfish

Ⓑ Figure 47. Mudfish pond now (left) and proposed design (right)

	Species	Common Name	Description	Habitat
1	Austroderia richardii	Toitoi	Tall slender tussock forming flax. Up to 3m high. Has reddish or yellowish colour flower in spring.	Common in stream banks, river beds and other wet places.
2	Juncus edgarae	Wiwi	Indigenous species. Bright to dark green tussock with flower clums.	Common in seasonally damp sites.
2	Carex tenuiculmis	Selender Wine Sedge	Tussock forming sedge, short and spreading with brown colour	Widespread in the wetland area, prefer moisture soil environment.
4	Cordyline australis	Ti Kouka	The most distinctive plant on farms with 12-20 meters high. Broad straight leaf.	Common in farmland open places

Table 15. Plant strategy of organic farm mudfish living area

4.3.2.3 Grazing Farm

- Farm spaces design: residential area front yard design

The residential redesign aimed to mitigate the waterlogging issue and enhance the circulation of the site by using Fengshui principles.

" 'Qi' will stop when it meets water, will lift when it meets wind". The best design should collect the 'Qi' to prevent it spreading out while forming a smooth flow to allow 'Sheng Qi' coming into the site (Guo, 1875). As shown in Figure 48, the existing stream in front of the house has a narrow water channel with low biodiversity along the bank area, which makes it hard to preserve "Sheng Qi" in front of the house. In Fengshui, the road is another form of water. The road, dwelling, and bridge were separated with no connection, which affected human activity and natural habitat connectivity. The redesign firstly widened the stream to slow down the water speed and allow "Sheng Qi" to come into the site smoothly. The layers of shrubs and stones along the bank were used to keep the balance of "Qi" and prevent bank erosion. A pond was designed in front of the house as a retention area. It connected the tributary from the hill near the woolshed with the stream, which could solve the issue of waterlogging in the rainy season while collecting the "Qi" to prevent it spreading out. A road with curved shape and high connectivity design allowed "Qi" to flow through the site fluently.

This redesign enhanced the flow of "Sheng Qi" off the site and collected it in front of the house (Figure 48). It flowed from the valley at the back of the house to the front of the house area. The forest and shrubs at the Watergate guided the "Sheng Qi" and slowed it down at the open space in front of the house.

Figure 48. The residential area now (left), and proposed redesign (right)

- Foothill eroded area planting strategy

Figure 49 showed the existing rill erosion on the hill slope. Water flow on the slope and the bare soil without shrub on the hill caused the erosion. The design concept was to plant native shrubs on the hill slope to mitigate soil runoff. The hand drawn redesign is of the high erosion area on the foothill. The site had a tributary on the hill with a serious water erosion issue. The existing vegetation forms a gap between branches, which could bring "Sha Qi" into the valley. The concept of the redesign was to use deep-rooted native shrubs to control soil erosion while reducing the speed of water and mitigating the rate of water erosion. Layers of shrubs should be planted horizontally through the tributary channel. Suggested plant species are listed in Table 16.

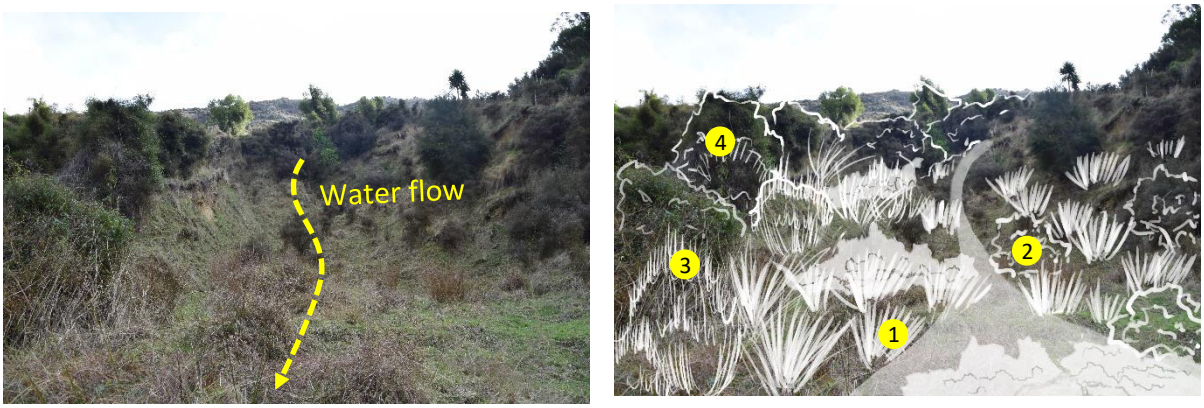


Figure 49. Foothill redesign

Table 16. Plant strategy of grazing farm hill slope area

	Species	Common Name	Description	Habitat
1	Dianella nigra	Turutu	Loose tussock forming evergreen herb at around 30-90cm tall. Long-rooted plant.	Common hill slope and stream banks. The root can control soil erosion, moisture tolerant.
2	Veronica lavaudiana	Heliohebe lavaudiana	Small shrub with red margined leaves. Endemic to Banks Peninsula. 50cm tall.	Prefers rocky places and riverbeds of the Banks Peninsula.
3	Austroderia richardii	Toetoe	Green tussock at around 1m high. Provides good shelter. Can contribute to erosion control	Prefers coastal or mountain areas.
4	Leptospermum scoparium	Ti Kouka	Shrub with pure white flowers with at 4m tall.	Prefers poorly drained soil hill slope areas.

4.3.2.4 Summary of the Detailed Farm Redesign

The detailed design of each farm showed that Fengshui principles could not only be applied in the site selection and large-scale layout design, the detailed scale landscape issues and environment could also be redesigned by using Fengshui. Differently to the layout redesign that provided an overall design concept, the detailed design focused on the spatial arrangement of every single element of the site. To achieve natural restoration, the design deviated a little from the original Fengshui concept, and selected indigenous species rather than Chinese species.
For each of the detailed redesigns, a variety of Fengshui Principles were used to support it. To address the water issue, the redesign considered the arrangement of the vegetation layer, water channel shape, seasonal change, and sun direction. The design considered the arrangement of each environmental features like stones, water, shrubs, tussock, soil, and microclimate to improve the native species' living habitat.

The detailed design showed the general application of the Fengshui Principles to the agricultural landscape. By changing the orientation of the landscape features, the function of the environment could be maximized and the harmony between human activity, agricultural production, and environmental protection could be balanced.

The detailed design borrowed the landscape ecology concept, especially on plant management. With the help of landscape ecology principles, the detailed scale design would be accurate and practical. Fengshui principles were too rough to be taken into practice for a designer with no practical background, while the landscape ecology principles would provide a native guideline with the unique characteristics of the farm.

Chapter 5. Discussion

The study demonstrated a correlation between Fengshui principles and farm design in New Zealand's Canterbury region compared with landscape ecology principles. The study analysed the landscape features including wind, water, soil, vegetation, structure, and roads on the farm based on Fengshui and landscape ecology principles. The interpretation of these two principles showed high similarity especially on the analysis of natural features like wind, water, soil, and vegetation. Moreover, the environmental issues including waterlogging, flooding, soil erosion and biodiversity loss on the farm could be interpreted by using Fengshui principles. After analysing the existing farm layout, the study redesigned the farm layout followed the principles of Fengshui and landscape ecology separately. The comparison of these two designs led to a new layout design that took advantage of these two principles.

The farm designs showed that the strategies of Fengshui principles had some similarities with landscape ecology-based design. Both of these principles emphasised the integrated function of the landscape features under appropriate arrangement and the effect of spatial layout on the farm environment, and they all aimed to keep a healthy natural system by changing or maintaining the layout of the farm. Fengshui principles preferred using the collaboration of all the landscape features on the farm to address the environmental issue systematically, the main focus was to provide an overall theoretical guideline on the layout design, hence improving the living environment on the farm. The landscape ecology approach on the selected farm only used the orientation and combination of vegetation to regulate the natural habitat on the farm and mitigate the environmental problems. Its detailed principles provided practical guidance on the farm design and focused on the livestock living environment, whereas the Fengshui approaches could achieve improving the living environment of farmers and employees on the farm. This research showed that these two theories could be integrated and applied to the farm layout design to enhance the natural restoration of the living environment for both livestock, humans, and other species on the farm. This work suggests that Fengshui could be applied to farms in the Canterbury region.

5.1 Case Study Farms' Environmental Conditions and Opportunities

The existing agricultural landscape in New Zealand is facing several environmental challenges including water logging, flooding, soil erosion, greenhouse gas emission, as well as ecosystem degradation (Ministry of the Environment, 2018; Department of Conservation, 2011; Manaaki Whenua, 2018; Haggerty & Campbell, 2008). Farmers and the local government have sought solutions from scientists to deal with these environmental challenges. As these environmental issues have been identified in the case study farms, it is possible to apply Fengshui into farm layout design to see whether it can contribute to addressing these environmental challenges or not.

Waterlogging was the drainage problem of a site. Fengshui and landscape ecology had different interpretations of this phenomenon. Landscape ecology analysed waterlogging from pedological, topographical, and climate reasons which affected the drainage ability. Landscape ecology suggested mitigating the problem by enhancing the connectivity of the drainage corridor or designing vegetation patches. Fengshui read the waterlogging by using the flow of "Qi". When the site was very flat, "Sheng Qi" could not be preserved, "Sha Qi" on the ground would bring a negative effect to the landscape, and waterlogging was a phenomenon of "Sha Qi". Fengshui suggested transferring waterlogging into an opportunity to create "Sheng Qi" by enhancing biodiversity in waterlogging areas and this concept was similar to designing vegetation patches in landscape ecology.

The flooding issue was common on the Canterbury plain farm. The landscape ecology analysed the flooding issue based on water velocity and geomorphic condition around the water channel. Landscape ecology addressed flooding by strengthening the physical and biological interactions between the water channel and its surrounding area. Landscape ecology preferred using ecological restoration to mitigate flooding. Fengshui interpreted Fengshui as overflowing of "Qi". It mitigated flooding from two perspectives. Firstly, Fengshui suggested widening the water channel and creating multi branches to spread "Qi" when it accumulated on the site and secondly, design a "Watergate Fengshui Forest" at the gate of the water channel before it flowed in and out of the farm to control the speed of "Qi". These two strategies were similar to the suggestion of landscape ecology. On the other hand, Fengshui brought the flow of "Qi", or so-called energy, into the flood control.

Soil erosion happened on the farm with a hilly landform. In landscape ecology, soil erosion on the slope area was caused by soil, wind, and water. It suggested using patches of vegetation to consolidate the soil which was to enhance the self-adjustment ability of the natural environment. Fengshui identified the erosion condition by two criteria: Fengshui forest location, and "Qi" flow direction. The "Foothill Fengshui Forest" was an essential vegetation patch at the lower hill slope area to protect the valley from being affected by soil erosion. The "Qi" flowed through wind and was carried by water so the hill slope area was vulnerable to strong "Qi". Fengshui suggest planting a "Foothill Fengshui Forest" on the hill slope and the living area should not be located close to the foothill. Both Fengshui and landscape ecology suggested using vegetation to address the soil erosion issue on the hilly landscape. The only difference was that Fengshui suggested creating a landscape layout that is human-based, the human living location and environment should be considered.

Biodiversity loss was more obvious on the intensive dairy production farm. Landscape ecology read the biodiversity loss as a phenomenon which lacked vegetation patches and connections to create a healthy natural ecosystem. Landscape ecology suggested enhancing the biodiversity habitat along the water corridor. Moreover, it suggested planting a low shrub shelterbelt for livestock to provide shelter for cows and a food source for birds. In Fengshui, biodiversity loss was also connected to "Qi". Differently from the waterlogging issue that was caused by "Qi", biodiversity loss caused the

site's "Qi" leaking problem. Without the thriving vegetation on the farm boundary and along the water channel to block and preserve "Qi", "Sheng Qi" would flow out of the site. Fengshui suggested planting a shelterbelt on three sides of the farm boundary while leaving an open boundary for wind to flow in and also selecting the plants that prefer a water bank or riverside area and plant along the water area to create a natural environment for a natural habitat. Landscape ecology suggested using the plants to enhance biodiversity on the farm, moreover, enhancing the living environment for livestock. Fengshui suggested using the plants to adjust "Qi" flow, then using "Qi" to enhance biodiversity.

5.2 Fengshui and the Agricultural Landscape in New Zealand

In this study, the farm layout design, space design, and planting area design were guided by Fengshui principles. The overall concept that drove the whole design was using the landscape features to regulate the circulation of "Qi". The flow of "Qi" in Fengshui could be explained in landscape ecology as being broken up into different types of flow like material flow, energy flow, and biological flow. Differently from the landscape ecology that was a function-based concept, Fengshui analysed and designed the site based on shape and form, it used different landscape features like water, soil, vegetation, road, and structures.

As a critical factor in Fengshui, water was the carrier of "Qi" flow. In this research, when analysing the farm by using Fengshui principles, the flooding, and waterlogging problem was directly related to the circulation and speed of "Qi" on the site. Fengshui suggested focusing on the "balance" condition of the environment. It suggested planting vegetation as natural patch around the waterlogging area to balance "Sheng Qi" on the site. For the flooding issue, Fengshui design emphasised the balance of plant size, shape, number, and texture on the side of the water channel. This approach was the extension of the vegetation corridor concept in landscape ecology.

Soil erosion in the farmland was closely related to the factors such as wind, distance from the river's concave bank, water flows, the density of the forest patch, and degree of slope. The effect of erosion had direct relationships with the location of the living area. "Qi" is not stable for the site with a soil erosion issue, which would have a negative effect on a stable living environment.

In Fengshui, "the thriving vegetation could attract animals and support a stable ecosystem". Based on this concept, factors like the density and area of vegetation patches, vegetation diversity, and microclimate could affect the resulting ecosystem services. Fengshui divides the vegetation patches based on location and each patch has a different function in the surrounding landscape (Appendix 1). Watergate Fengshui Forest can block the cold wind from the river outfall area, hence preventing "Sha Qi" from outside the farm and protect the farm from flooding in the rainy season. Footstone Fengshui Forest can help mitigate the effect of soil erosion by rain wash. Back Mountain Fengshui Forest can help form an "armchair" environment to modify the macroclimate. In the farm layout

design, Fengshui Forest uses vegetation patches to adjust the microclimate and protect the farm from environmental challenges like flooding and soil erosion.

Structure and road were not the major focus in the three farms' layout redesign based on landscape ecology. Actually, landscape ecology mentioned that clusters of structures were another form of landscape patch and the road was the corridor in the farm for human movement (Forman, 1995). The design of structures and the road could also affect the systematic function of the farm landscape. Fengshui, a human-based landscape design concept, emphasised the importance of the structure orientation and shape of the road. The building should face the north with enough sunlight, it should be located in "Ming Tang" which is a flat area with a water flow at the front, sheltered by hill or shelterbelt. The key was to keep the balance between a comfortable living area and a well-protected natural environment. The road was another form of water, it contributed to the integration and connectivity of "Sheng Qi". Fengshui suggested designing the road curvedly to slow down and preserve "Qi", meanwhile, it was of benefit to plants growing along the roadside. Landscape ecology suggested that roads should be designed as straight. The difference between these two concepts showed that Fengshui provided a new insight towards road design.

Fengshui identified and analysed the farm from an Eastern viewpoint, which was different from the site analysis based on landscape ecology principles. In this research, the farm design showed a high potential of combining these two theories as a comprehensive design that addressed environmental issues, natural preservation, livestock and human activity.

5.3 Perceptions and Potentials of Applying Fengshui on the New Zealand Farm

According to Fahrig (1997), landscape ecology plays a role in recognizing and supporting landscape services regulation in the agricultural system. It could help to enhance the restoration and preservation of the natural ecosystem and maintain the integration of the farm environment. On the other hand, landscape ecology is already rooted in landscape design and regional legislation of agricultural management. Farmers and local government need a bridge to ease the conflict between production and environmental protection (McFadden, 2018). As holistic knowledge, Fengshui could provide an alternative perspective to ecological science. The relationship between landscape ecology and Fengshui has been shown to have similarities and differences. The Seoul City planning research found that some Fengshui principles' elements could correspond to the landscape ecology theory as shown in Table 4 (Anderson, 1996; Han, 2001; Hong, Song, & Wu, 2007). The relationship between landscape ecology and Fengshui needs further study as the science of Fengshui is yet to be fully accepted by Western scholars (Eitel, 1987; Bruun, 2008).

The site's interpretation considered landscape features on the farm, including wind, water, soil, vegetation, structures, and roads. Based on the case study of the farm in the Canterbury region, the

analysis by using Fengshui was similar to the landscape ecology analysis, which identified similar environmental challenges, opportunities, and potential hazards on the farm. This result was in line with the theory comparison written by Hong, Song, and Wu (2007). The overall analysis using Fengshui principles focused on the circulation of “Qi”. It could address the environmental challenges on the farm. The suggested strategies had high similarity compared with landscape ecology principles. On the other hand, site stability and comfort were also included in Fengshui which was related to human living experiences on the farm. The environmental challenges could affect these two aspects.

The redesign of the farm in this study showed the variation between using Fengshui and landscape ecology. The Fengshui redesign could help plan the overall layout of the farm to regulate its “Qi” movement. Differently from achieving biodiversity preservation by making full use of the function of the native plants, the redesign based on Fengshui principles used the theory of siting direction (坐向论) to regulate the orientation and spatial arrangement of each landscape feature. Each landscape feature could affect the overall landscape. The redesign by using Fengshui principles achieved the balance of environmental restoration and human activity.

Fengshui in New Zealand agriculture can contribute to connecting agricultural management with farmers, hence mitigating the conflict between farmers and the regional councils. In this study, design principles were not in conflict with legislation. So, farmers would be able to improve their living environment while achieving natural restoration and agricultural production. The transformation and application of Fengshui showed the possibility of introducing an Eastern landscape belief system into a Western country. The use of Fengshui required a different set of environmental beliefs to be used in farm restoration.

Chapter 6. Conclusion

6.1 Summary of the Findings

In Asian countries, Fengshui is be applied in many fields including landscape design, settlement location selection, urban design, rural farm design, and village planning. This research used Fengshui principles and landscape ecology principles to guide three farms' layout designs and detailed designs, which addressed existing environmental challenges including waterlogging, flooding, soil erosion, and biodiversity loss. After the comparison, this research found that Fengshui design approaches considered the living quality of humans, while the design following landscape ecology principles of Forman (1995) focused on the living habitat of livestock. After analysis and comparison using Fengshui and landscape ecology principles, these two concepts could be combined, and hence cater for the needs of environmental conservation, livestock and human living. The study suggested that the Fengshui principles could be applied as a guide in the site inventory, analysis, and landscape layout design in New Zealand, and cater for farmers' wellbeing and lifestyle quality, which landscape ecology ignored in the case study. To better fit into the existing landscape character, Fengshui principles could be applied together with landscape ecology principles and keep the balance between landscape restoration and agricultural production.

Depending on the landscape characteristics and background culture, Fengshui could be localized to fit into the local environment while maintaining the key concept, "Qi". This study supported the concept of Fengshui localization as pointed out by Chen and Nakama (2010). In this study, the Fengshui design approaches of three farms were discussed from Chinese and Japanese case studies. Moreover, some of the Fengshui approaches were adjusted based on the New Zealand local habitat and absorbed the landscape ecology principles, especially on the plant species selection and shelterbelt pattern. This kind of transformation and localization showed that it was possible for Eastern knowledge be applied in a Western country without disturbing local environmental characteristics.

6.2 Limitations

The methodological choices were constrained by time and technology. For each selected farm, the site visit only happened once in autumn. The seasonal changes of the agricultural landscape like water level rise, vegetable harvest, and livestock moving were not observed during the single site visit. The site visit had many shortcomings that affected the site observations: the site visit time was too short to collect all information; many viewings could not occur due to the restriction by landowners; and much information about the farm was missed without the opportunity to communicate with farm owners. The accuracy of the data was limited by the technologies. Data like

photos, videos, and personal experiences were not as accurate as LiDAR when digitizing the farm's spatial information.

The following reasons limited the generalizability of the results. Firstly, this research only selected three farms in the Canterbury region as case study, but were not indicative of the Canterbury farms as a whole. This result only provided a suggestion that Canterbury farms could apply Fengshui in the farm layout design. Secondly, in this research, we only used the Form School Fengshui to analyse and design the farm; theory from the Compass School was not considered to guide the research because its principles were more relative to human fortune and wealth. Thirdly, the landscape ecology principles discussed were only based on the project provided by Dan Cameron, it could not represent the landscape ecology study boardly. Fourthly, this research compared the function and design of landscape ecology; and Fengshui theoretically, the result was lacking in real experience on the farm.

6.3 Future Recommendations

Future studies can take into account how to use modern technology to address the application of Fengshui into the farm analysis, which will contribute to the accuracy of environment interpretation. Other than that, the comprehensiveness of the data collected on the farm affects the result of the research. This research suggests that more information needs to be collected and analysed. For example, seasonal change on the farm may provide more information about the environmental challenges. As this research provides a suggestion of the application of Fengshui in the farm layout design in New Zealand, further research can be focused on the generalizability of Fengshui principles to other types of farms in Canterbury region. So far, based on the existing literatures and studies, discussion of the Fengshui application in Western countries remains at the theoretical level. It is worth doing experimental research on the real farm by implementing the principles of Fengshui in a real rural farm landscape design. This research provides a chance for landscape architects to read the agricultural landscape and address environmental issues with an Eastern design. Further study can apply Fengshui in the broader landscape design, such as residential landscape design, urban planning, and landscape assessment in Western countries.

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APPENDIX 1: Detailed Fengshui Principles

Site Selection Criteria

This part introduces the basic theory of site selection in the Fengshui Form School. When people encounter the environment, the following theories can be used to evaluate the basic environmental condition of the site. According to Han (2001), there are five features including:

- Spatial Configuration and Depth Cues

  An ideal Fengshui location is a semi-enclosed space for farmland and settlement with mountains surrounding it at the back, left, right and relatively open at the front. This kind of arrangement forms a defensive arrangement against cold and wind.

- Focal Points

  Focal points are groupings of features to catch people's attention and make it easy to monitor the natural environment. The back mountain, Hsuan Wu, is the obvious focal point. The lower mountains, Pai Hu and Ch'ing Lung, are the secondary focal points.

- Ground Texture

  The centre of the Fengshui location should be smooth and have uniform ground texture. Since the centre is mostly used for agricultural activity and settlement, the continuous even-textured surface can help perceive depth and benefit to growing food.

- Water and Vegetation

  A winding inward river flow in front is the ideal Fengshui location which provides a resource for drinking, irrigation, agriculture, air purification, microclimate modification and humidity. The Fengshui location also requires thriving vegetation to attract animals and support a stable ecosystem.

- Information Gathering and Cognitive Appraisal

  After gathering and analysing the general features of the landscape, the next step is to orient the space and make it perfect. The goal of this stage is to minimize risks from both nature and human activities. The landscape can be seen as a whole and we need to arrange it in advance.

Fengshui Glossary:

In Fengshui, each landscape features has its unique proper noun. This part uses Figure 50 as an Fengshui village example to explain each proper noun.

Figure 50. Fengshui village example

- The Black Turtle (Hsuan Wu):

  One of the four celestial animals in Fengshui. It represents North (or the back side as you look out the front door) and provides steady and reliable energy. In the Form School, Black Turtle mountain can protect the farm at the back.

- The White Tiger (Bai Hu)

  One of the four celestial animals in Fengshui. It represents West (or the right side as you look out the front door).

- The Green Dragon (Qing Long)

  One of the four celestial animals in Fengshui. It represents East (or the left side as you look out the front door).

- The Red Phoenix (Zhu Que)

  One of the four celestial animals in Fengshui. It represents South (or the front side as you look out the front door). In the Form School, the Red Phoenix direction prefers open space and a good view.

- The Dragon Nest (Ming Tang)

The ideal spot for a home or village. The word Ming Tang can be used at different scales. At regional scale, Ming Tang is the urban city. At district scale, Ming Tang is the village. This is a location in which people gather and live.

- Watergate Fengshui Forest

  A type of forest that is designed to guard against cold wind from the watergate, hence it protects the people who lives in the village. Without planting the Watergate Fengshui Forest, Sha Qi will flow into the valley and cause a negative effect on the environment like erosion, strong winds, and heavy storms. In summer, the wind would carry the rain and blow into Ming Tang which has the potential to flood.

- Back Mountain Fengshui Forest

  This type of Fengshui Forest is designed to protect the village in Ming Tang from soil erosion at the Black Turtle mountain. Moreover, it can help to block the strong wind from the mountain valley. Without the Back Mountain Fengshui Forest, it is hard to adjust the microclimate in the valley.

- Footstone Fengshui Forest

  The Footstone Fengshui Forest is planted at the lowland slope of the Green Dragon and White Tiger mountains. It can protect the hill from soil erosion and protect the dwelling in Ming Tang. The trees of the Footstone Fengshui Forest should not be too high.

Other than the proper nouns above shown in the Figure 44, there are some more words mentioned in this research.

- Qi

  Qi is closely related to water. Qi stops when water stops. In turn, water follows the Qi flow. In other words, water is what we can see on the surface, Qi is the energy inside. To examine the movement of Qi, we can look at the flow of water.

- Sheng Qi

  A kind of Qi which appears when the surrounding landscape is vibrant, flowing, meandering, and lush. When Qi sinks low and disperses, it disappears and when the landscape become flat and stiff, it will gone. Sheng Qi can be cultivated by adjusting the Yin and Yang balance of the situation.

- Sha Qi

  This negative and menacing energy is opposite to Sheng Qi and halts the growth of life.

General Fengshui Principles

According to Cai (2009), there are 15 core principles in the Fengshui Form School.

- An Integrated and Holistic System

  We should work with nature rather than against her. We not only need to consider the individual parts but also their relationship to each other. Man is part of nature, nature has universal laws which Man should follow.

- Being Suitable and Appropriate to the Limitations and Restrictions of the Site

  Every site has its limitations and advantages. Some places are only suitable for commerce or manufacturing while others are suitable for residential use.

- Settlement Better Located Near Water and Bound by Mountains

  Mountains are “skeletons” of the landscape. They can not only protect us from weather, but also provide food and resources. Water is the source of life from which Seng Qi is obtained.

- Observe the Form and Examine the Configuration of Land

  For the landscape architect, this principle can help to understand the site in a holistic way, thus creating building or landscape that will fit naturally with its surrounding landscape.

- Taking Advantage of Sheng Qi

  The aim of Fengshui is to locate the building in places where there is Sheng Qi.

- Greening the Environment

  Trees and woods are the source of Sheng Qi. They can also protect the house from the cold wind and provide a strong protection at the back while embracing the Qi at Ming Tang.

- Fengshui can be Improved and Transformed

  The natural environment should be respected at all times, but it can be remoulded to improve its quality. The mountains and valleys are made by nature, but human can tailor and fashion the landscape.

- Yin Yang Dialectics to Achieve Harmony

  Without the contrast of Yin and Yang, qi will not flow. The concept of Yin and Yang is more about keeping the balance in the environment. To assess the Fengshui of a place there are many complementary opposites in the landscape:

Hard and soft; moving and stationary; stem and branch; form and configuration; mountain and water; deep and shallow; alive and dead, etc.

More Detailed Fengshui Principles

The following Fengshui principles shows the tips for site selection and detailed requirement of landscape design.

- Hsuan Wu should be magnificent, for the South Hemisphere, it is located in the south, with natural slope for drainage.
- The more mountain or hill surrounding, the better the environment's natural shelter against hazards.
- All surrounding mountains and hills should curve inwards the centre of Ming Tang.
- Avoid stony or solitary mountains which are difficult for farming and lack of ecological diversity.
- If the site is too flat and lacks large mountains, vegetation such as a Fengshui Forest arranged behind and at two sides of the dwelling can remedy the imperfect landscape.
- Ming Tang should be a relatively flat area on a gradual slope with good drainage for farmland.
- An Shan is the hill in in front of Ming Tang, it should be too low or too high. A river curving inwards should flow between An Shan and Ming Tang. The ideal site is located at the convex bank side of the river to prevent gradual erosion and potential hazards.
- The river should not flow noisily, muddily or rapidly to avoid erosion. Avoid a yellow colour coloured river which is not suitable for drinking or irrigation.
- A river with many curves or of good quality can maximize Fengshui and indicates high food productivity for agriculture and a stable ecosystem for the natural environment.
- The sites where the river enters and exits should be surrounded by a mountain or hill.
- The entrance of the river should be wide, the exit of the river should be narrow.
- If the river or lake is on the right, Hsueh should also be on the right side. (Hsueh means the location of people's houses).
- The quantity of the river should be positively correlated to the magnitude of Hsuan Wu. The larger the Hsuan Wu mountain, the larger the river is and vice versa.
- The fengshui site should be oriented towards the north in the Southern Hemisphere.

APPENDIX 2: Field Notes for Site Visit

Farm 1: Dairy Farm

Date July 3 Time 9-12 am Weather sunny Recording ☑

Stream on the site Rat grass grows along the bank	Flow direction	To Southeast ↘				
	House locateed at convex bank?	Yes ☐ No☑				
	Sound (recording)	Loud ☐ Medium ☐ Low☑				
	Speed	Fast ☐ Medium ☐ Slow☑				
	Erosion	Obvious ☐ Medium ☐ Not obvious ☑				
	Colour 📷	Clear, no colour				
	Quantity📷	Large ☐ Medium ☐ Small ☑				
Drainage	Location	Note on map				
	Direction	Note on map				
	Type	Pipe ☐ Channel ☑ Kerb □				
Ground	Land Cover	Pasture				
	Growing Condition	Good, no weeds				
Forest	Forest 📷	No ☑ willow trees on the west side (council)				
	Forest Location	N ☐ S ☐ W ☐ E ☐ Other:				
	Density 1m2	N/				
	Diversity 1m2 📷	N/				
Vegetation In front of dairy farm for decoration	Density 1m2	≈4				
	Diversity 1m2 📷	Toitoi, Hebe, Flax				
	Location Note on map	At river entrance ☑ low plants along the bank At river exit ☑ short plants, moisture in winter Around house ☑ shrubs block the house				
Wind	Direction Note on map	N ☑ summer S ☑ winter W ☐ E ☐ Other:				
Farmland	Crop Type 📷	Note on map				
	Dairy type 📷	Milk Powder				
Dwelling	Type	Office,milk tank, staff house, owner's house				
	Orientation 📷	North	South	West	East	Other
	House for living Note on map					
	Other building Note on map					
	Office Staff House Owner's house	☑ ☑	☑			
Notes	Stream	The distance from the center of the river to cows should >5m				
	Issue on the site	The site has waterlogging issue on some of the area The earthquake changed the landform				
	White line	Has shelterbelt around the site Circle shape, cows walk follow the line				

Farm 2: Organic Farm

Date July 10 Time 10am-11.30am Weather sunny Recording ☑

Stream The stream channel is dry now	Flow direction	To Southeast ↘				
	House located at convex bank?	Yes ☐ No ☑				
	Sound (recording)	Loud ☐ Medium ☐ Low ☐				
	Speed	Fast ☐ Medium ☐ Slow ☐				
	Erosion	Obvious ☐ Medium ☐ Not obvious ☐				
	Colour 📷					
	Quantity📷	Large ☐ Medium ☐ Small ☐				
Drainage	Location	Note on map				
	Direction	Note on map				
	Type	Pipe☐ Channel ☑ Kerb ☐				
Ground	Land Cover	Pasture, growing winter crop for cows to eat				
	Growing Condition	Good				
Forest	Forest 📷	Yes ☐ No ☑				
	Forest Location	N ☐ S ☐ W ☐ E ☐ Other:				
	Density 1m2					
	Diversity 1m2 📷					
Vegetation	Density 1m2	≈2				
	Diversity 1m2 📷	≈2				
	Location Note on map	At river entrance □ At river exit □ Around house ☑ on the corner of the building				
Wind	Direction Note on map	N ☑ S ☐ W ☐ E ☐ Other:				
Farmland	Crop Type 📷	Note on map				
	Dairy type 📷	Milk Powder				
Dwelling	Type	Staff house, machine shield				
	Orientation 📷	North	South	West	East	Other
	House for living Note on map					
	Other building Note on map					Northeast
	Machine shield Staff house					Southeast
Notes	Water Channel	Farmer had planted a lot of vegetations along the water bank, only minority of them survived.				
	Natural Restoration	A large patch on the south part of the farm was prepared for natural restoration.				
	Other	Organic farm was not allowed to use any fertilizer.				

Farm 3: Grazing Farm

Date July 31 Time 11am- 12:30pm Weather cloudy Recording ☑

River Seasonal river, dry season now	Flow direction	To Southeast ↙				
	House locateed at convex bank?	Yes ☐ No ☑				
	Sound (recording)	Loud ☐ Medium ☐ Low ☐				
	Speed	Fast ☐ Medium ☐ Slow ☐				
	Erosion	Obvious ☐ Medium ☐ Not obvious ☐				
	Colour					
	Quantity	Large ☐ Medium ☐ Small ☐				
Drainage	Location	Note on map				
	Direction	West to north				
	Type	Channel☑＋Natural Drainage				
Ground	Land Cover	Grass, native plants, organic plants				
	Growing Condition	Some native plants are dead				
Forest	Forest	Yes ☑ No ☐				
	Forest Location	N ☐ S ☐ W ☐ E ☑ Other: Pine Forest				
	Density 1m2					
	Diversity 1m2					
Vegetation	Density 1m2	4				
	Diversity 1m2	4				
	Location Note on map	At river entrance ☐ At river exit ☑ Around house ☑				
Wind	Direction Note on map	N ☑ S ☑ W ☐ E ☐				
Farmland	Crop Type					
	Dairy type	Extensive Sheep Farm				
Dwelling	Type	Residential, Woolshed				
	Orientation	North	South	West	East	Other
	House for living	☑				
	Woolshed (Abandoned)			☑		
	The woolshed was located on the foothill, the surrounding environment had waterlog, flooding, and erosion potential.					
Notes	Landform	Hills, valleys, Big Bay, Blind Bay				
	Environmental Issue	High aesthetic and ecological value Flooding, soil erosion				
	Landowner Request	Natural restoration, low modification				
	Road	Single road from ridge to the living area				